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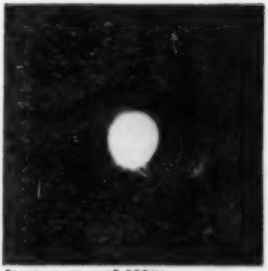

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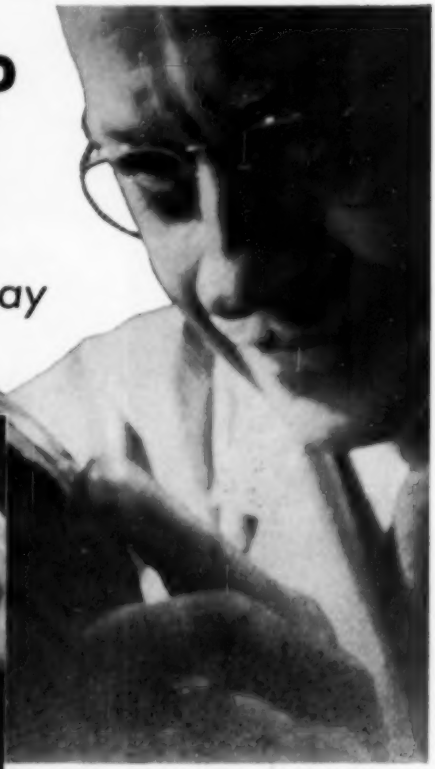

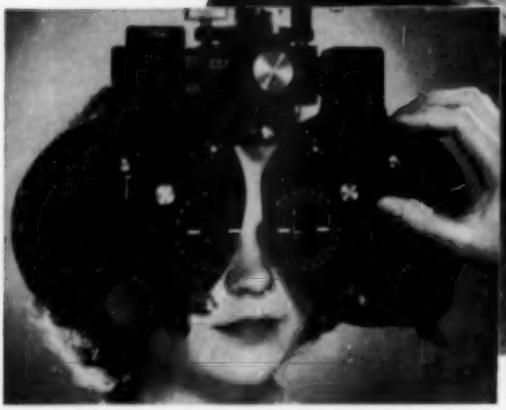

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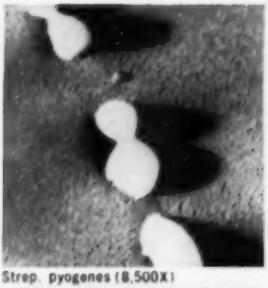

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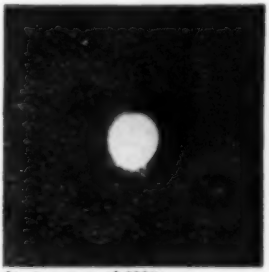

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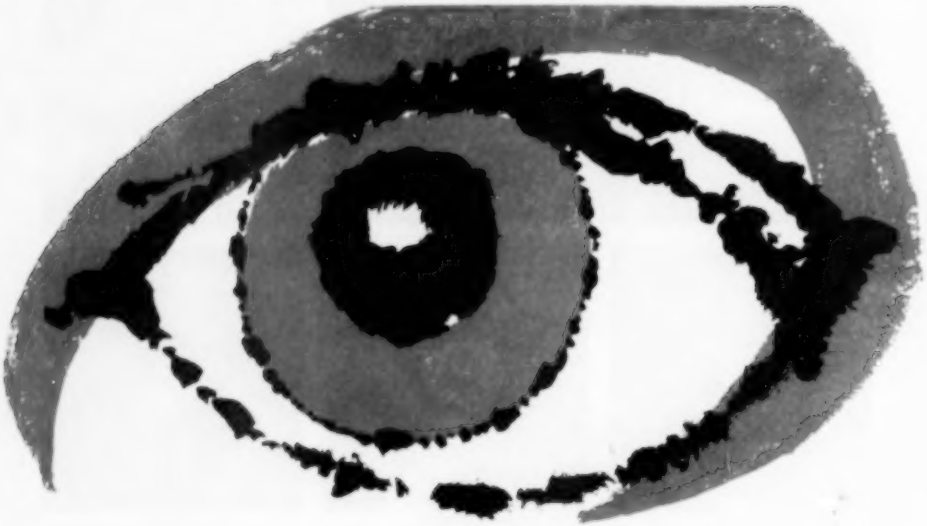

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1. Rukes, J. M., et al.: Metabolism 3:481, 1954.
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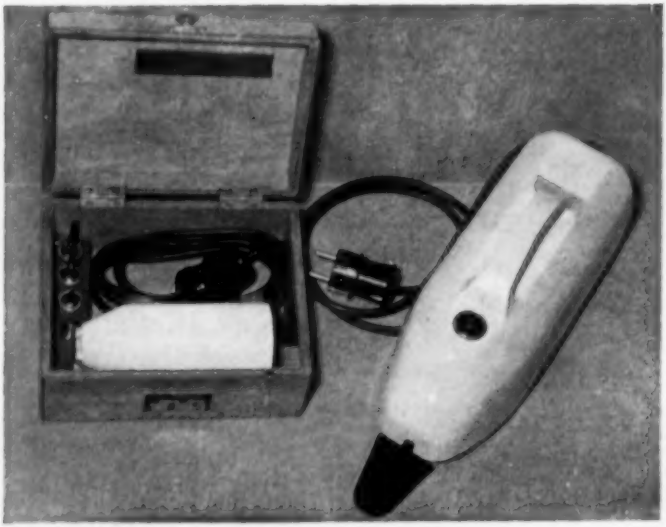

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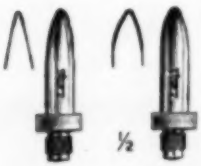

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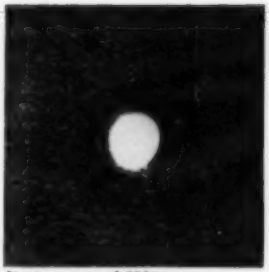

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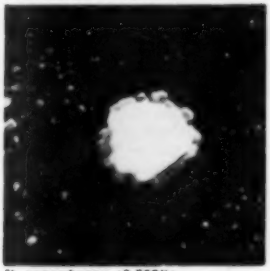

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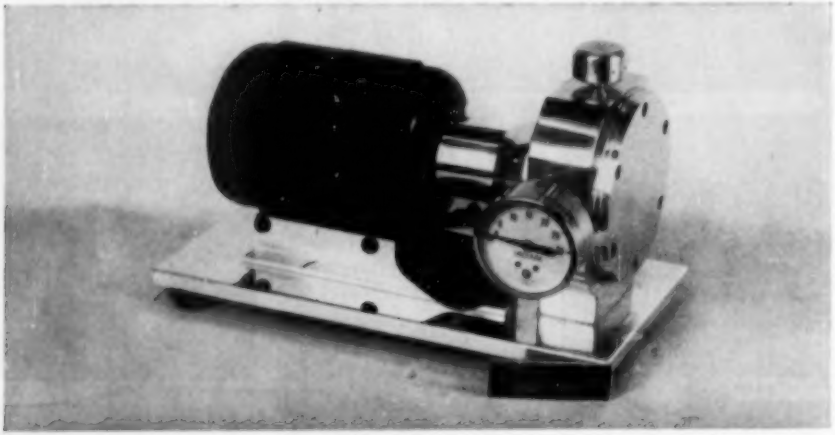

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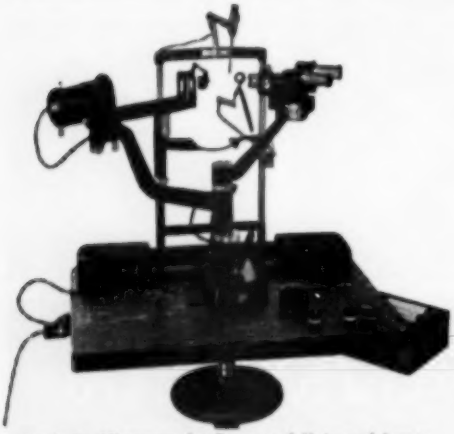

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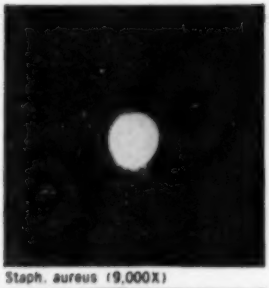

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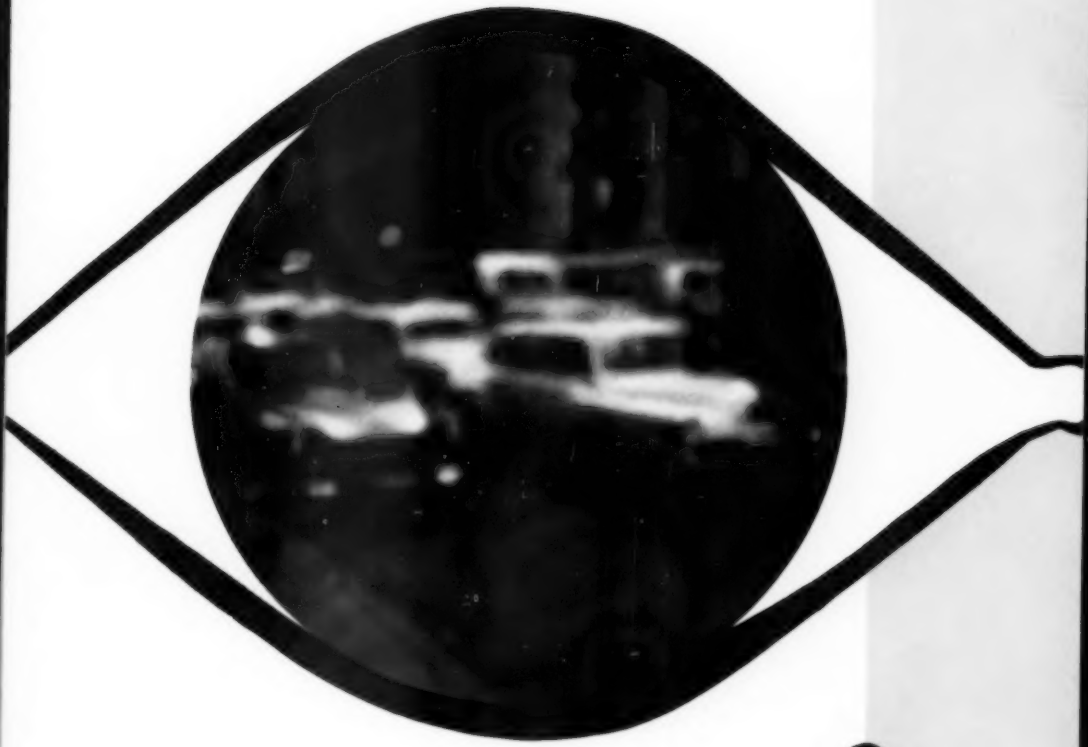

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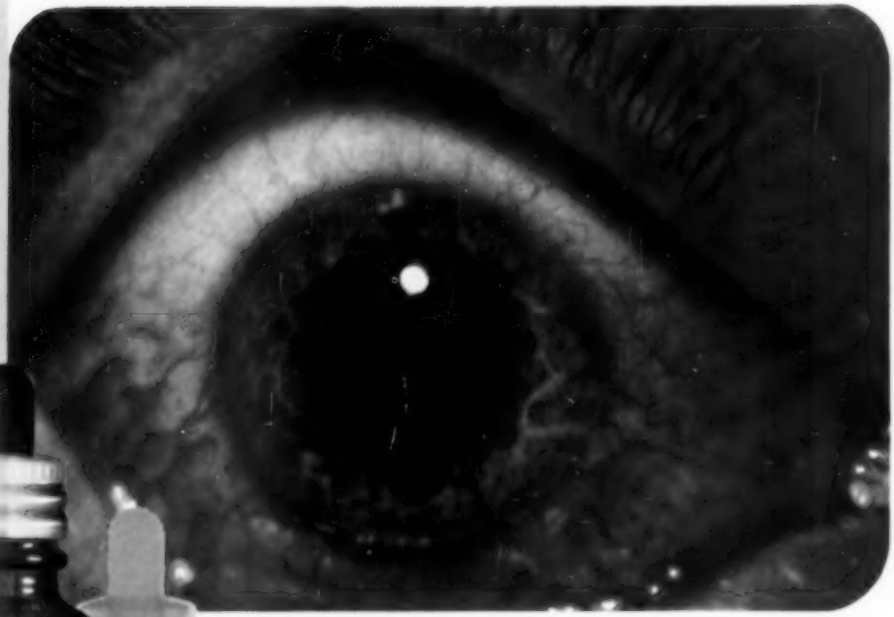

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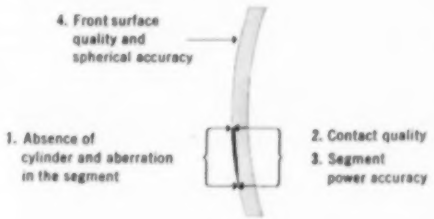
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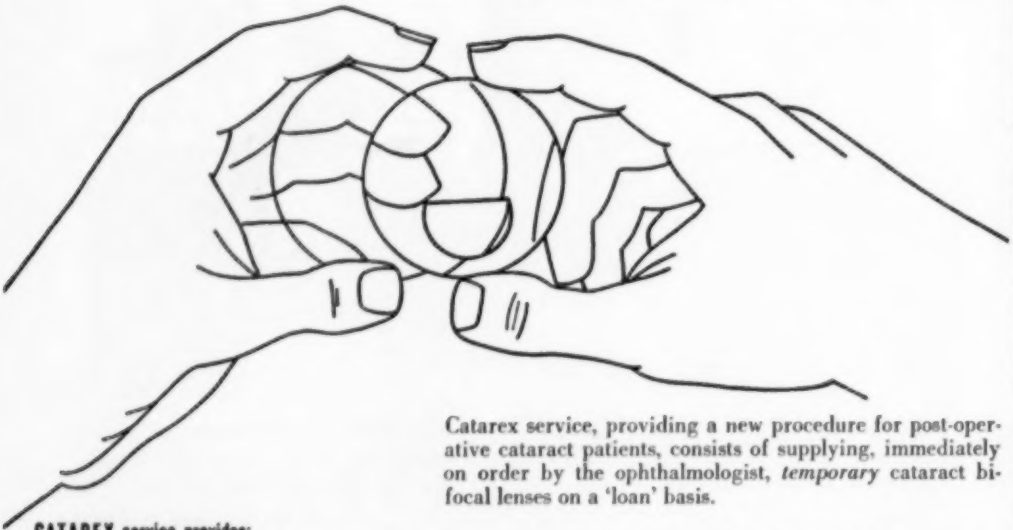

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The organisms commonly involved in

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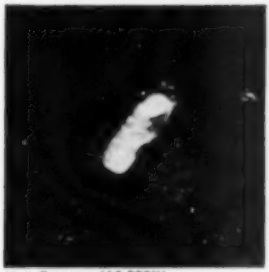
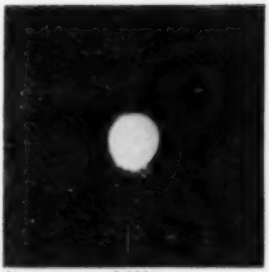


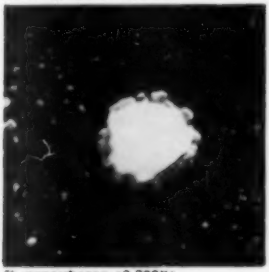
H. influenzae (16,000X)

Strep. pyogenes (8,500X)



Staph. aureus (9,000X)

D. pneumoniae (10,000X)



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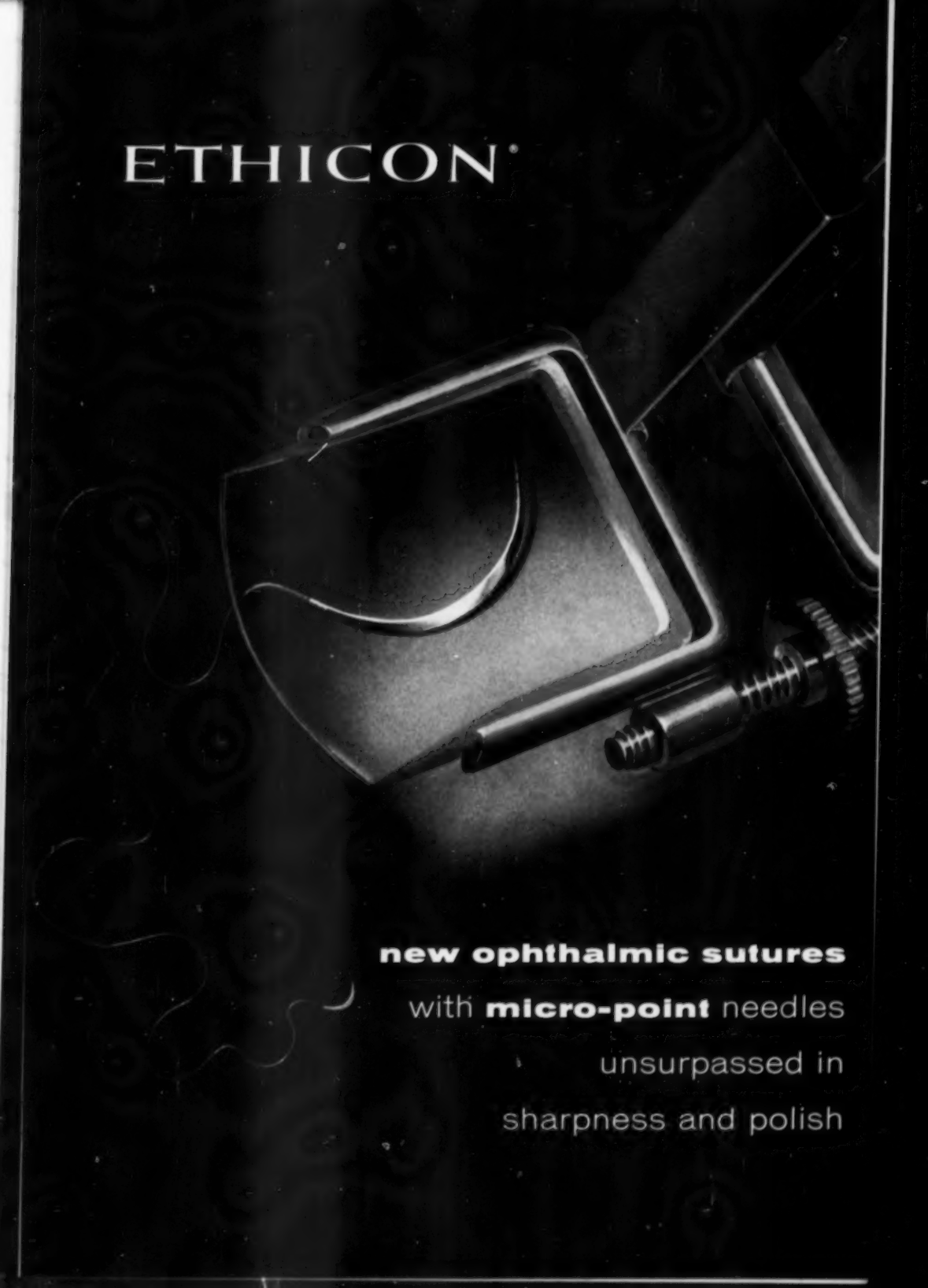

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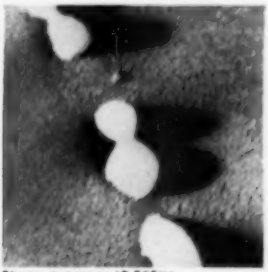

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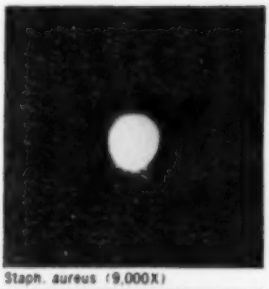

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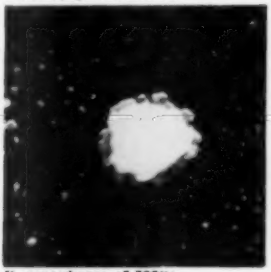

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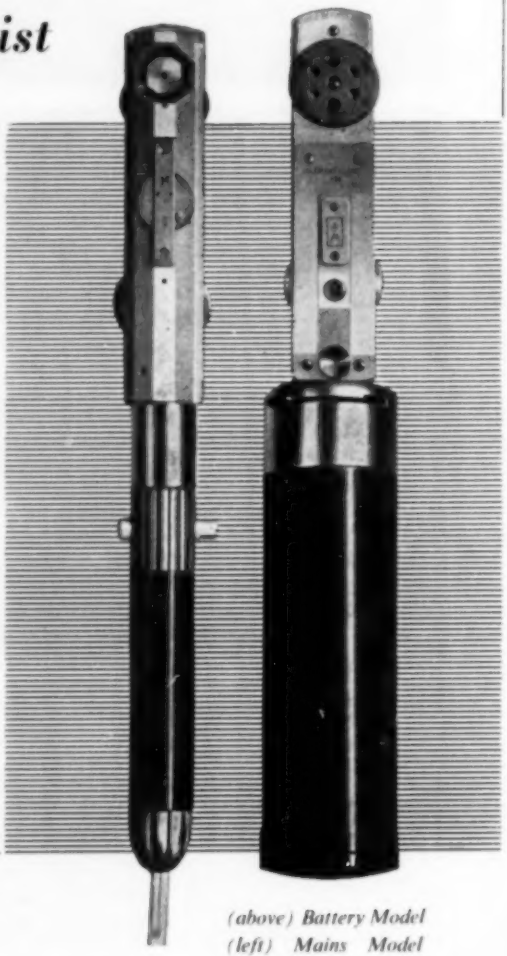

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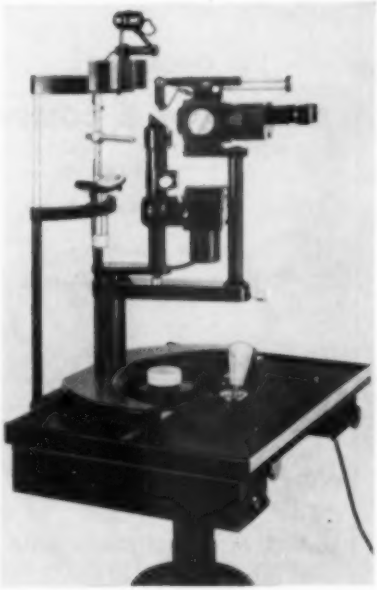

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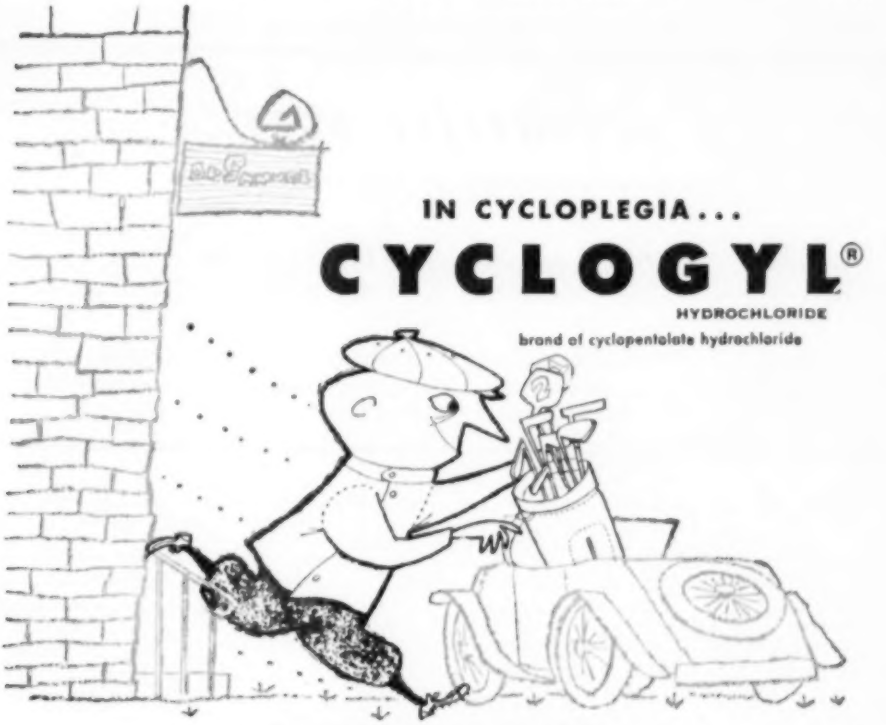

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†Recovery time reduced to six hours after one-percent pilocarpine.

1. Gordon, D. M., and Ebrenberg, M. H.: Am. J. Ophth. 38:831 (Dec.) 1954.

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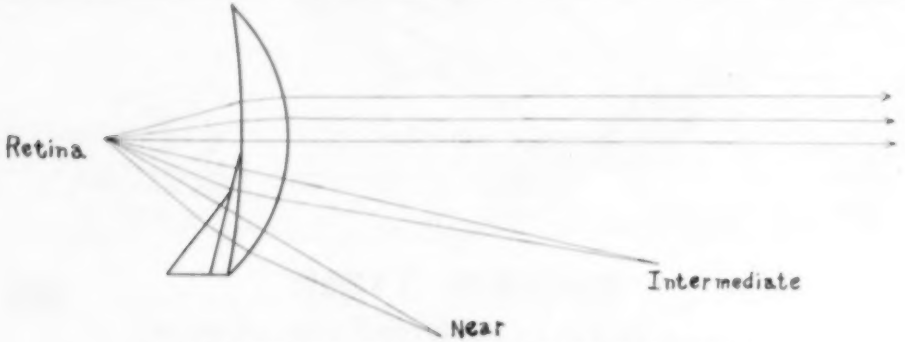

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AMERICAN JOURNAL OF OPHTHALMOLOGY

SERIES 3 · VOLUME 40 · NUMBER 4 · OCTOBER, 1955

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ABSTRACTS

Conjunctiva, cornea, sclera; Uvea, sympathetic disease, aqueous; Glaucoma and ocular tension; Crystalline lens; Retina and vitreous; Optic nerve and chiasm; Neuro-ophthalmology; Eyeball, orbit, sinuses; Eyelids, lacrimal apparatus; Tumors; Injuries; Systemic disease and parasites; Congenital deformities, heredity; Hygiene, sociology, education, and history 593

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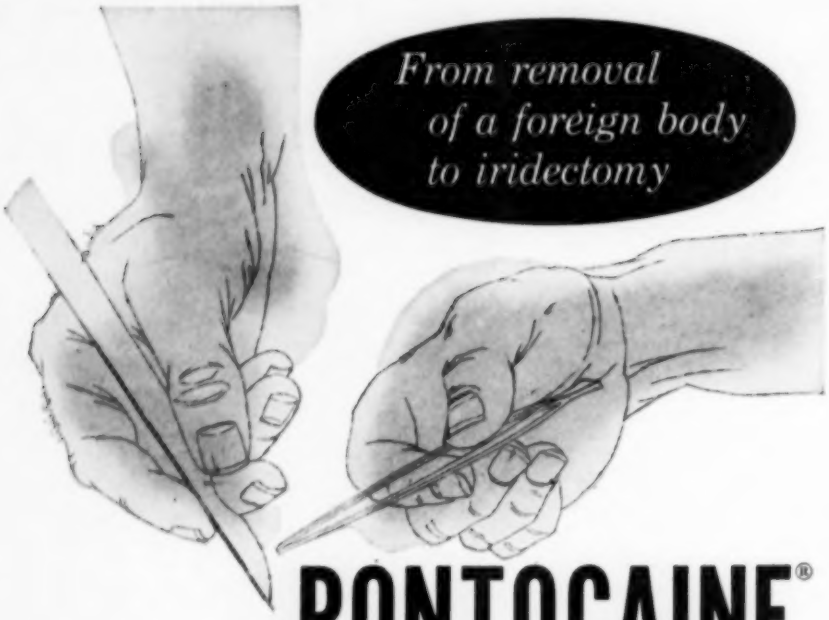

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VOLUME 40 OCTOBER, 1955 NUMBER 4

PERIPHERAL IRIS CRYPTS

IN RELATION TO MEDICAL AND SURGICAL THERAPY OF NARROW-ANGLE GLAUCOMA*

ADOLPH POSNER, M.D.
New York

INTRODUCTION

It is generally agreed that closure of the angle of the anterior chamber accompanies elevation of intraocular pressure in narrow-angle glaucoma and that reopening of the angle is associated with the drop in pressure which occurs either spontaneously or as a result of medical treatment. It has been clinically established that in narrow-angle glaucoma, closure of the angle is caused by circumferential contact between iris and cornea and that this contact occurs initially at the entrance to the angle where it is in most cases detected by slitlamp examination. This "iris block" occurs almost exclusively in eyes in which the entrance to the angle is anatomically so narrow that further narrowing gives rise to embarrassment of the aqueous circulation.

"IRIS SUCTION" HYPOTHESIS

Attempts have been made to explain "iris block" as a crowding of the angle by iris tissue (as in "dilation glaucoma"), or as a swelling of the ciliary body, or as a forward displacment of the lens. These hypotheses are not fully consistent with the fine results obtained by a small peripheral iridectomy which leaves the root of the iris intact and merely establishes a communication between the posterior and anterior chambers.

In a recent report I[1] suggested an alternate explanation for the closure of the angle and the accompanying rise of tension in narrow angle glaucoma. A similar view had been proposed by Czermak in 1897[2] but was ignored by subsequent authors, probably because the secretion theory was displaced temporarily by the dialysis theory of aqueous circulation.

Circumferential contact between iris and cornea at the entrance to the angle prevents aqueous from reaching the peripheral zone of the anterior chamber. The aqueous contained in the peripheral zone soon drains off and the root of the iris is held against the trabecula by suction from Schlemm's canal where the pressure is relatively low. The normal hydrostatic pressure in Schlemm's canal and the episcleral veins is about 10 mm. Hg, while the pressure behind the iris, represented by the intraocular pressure, is 20 mm. Hg. In the absence of aqueous in front of the iris to equalize pressures, the iris assumes a convex shape which is referred to as "physiologic iris bombé." Since the drainage channels are blocked by the iris being held against the trabecula, the pressure in the posterior chamber rises as a result of both the continuing formation of aqueous and the osmotic imbibition of water by the already formed aqueous.

This "iris suction" hypothesis explains the mechanism of the acute attack as well as the curative action of iridectomy in narrow-angle glaucoma. An iridectomy establishes a permanent communication between the posterior chamber and the periphery of the anterior chamber, and equalizes the pressures between these chambers thereby eliminating the causative factor of the acute attack of glaucoma.

* Awarded the Lucien Howe Prize for 1955 by the Medical Society of the State of New York. From the Manhattan Eye, Ear and Throat Hospital.

Other factors

In addition to the role of the narrow angle in acute glaucoma, there remain two important questions to consider concerning the pathogenesis of this disease:

1. Since the width of the angle is the same in both eyes, how is it that many individuals suffer from recurrent attacks of narrow-angle glaucoma in only one eye, while the other eye is either completely or relatively free of attacks? In a statistical study, Posner and Schlossman[3] found that one eye only was involved in 31 percent of patients with congestive glaucoma observed over periods of several years. This percentage stands in sharp contrast to chronic simple glaucoma in which monocular involvement was observed in only 9.6 percent.

2. An anatomically narrow angle is present in about 10 percent of the random population and recent studies[4, 5] seem to indicate that it is an inherited characteristic. Why is it, then, that fewer than one percent of the population develop narrow-angle glaucoma, and that even in these individuals the narrow angle may be observed many years before symptoms develop? Of interest, in connection with this question is the finding, in a study by Posner and Schlossman[3] of a relatively high incidence of acute congestive glaucoma in the older age group, specifically in the five-year period between 76 and 80 years of age.

In answering these questions, some authors claim that narrowing of the angle is just a predisposing factor. Numerous precipitating causes have been suggested, chiefly psychosomatic factors, the endocrines, physical and mental fatigue, overuse of stimulants, or exposure to darkness. All these factors may have significant roles, varying in importance from case to case. At best, however, their effects are vaguely understood and are difficult to evaluate.

Role of peripheral iris crypts

It may be possible to explain on a simple mechanical basis why certain eyes with narrow chamber angles are subject to attacks of glaucoma while others are not. As a corollary to the iris suction hypothesis, closure of the angle presupposes the formation of a watertight barrier between the central and peripheral zones of the anterior chamber. A defect in the anterior surface of the iris, such as a pit or crypt, when suitably placed, may create a leak in the barrier, so that communication between the center and periphery of the anterior chamber is assured and the eye is safeguarded against glaucomatous attacks (fig. 1).

This explanation suggested itself in the course of slitlamp and gonioscopic studies conducted on a group of patients who suffered repeated glaucomatous attacks in one eye whereas the other eye was completely free of such symptoms as blurred vision, halos, or pain. In the majority of the patients examined, the anterior leaf of the iris of the glaucomatous eye presented an uninterruptedly smooth surface, while the iris of the fellow eye exhibited one or more sharply delineated crypts in the periphery, opposite the limbus or slightly central to it. Further observations on a large number of patients, both from private practice and from the Glaucoma Clinic of the Manhattan Eye, Ear, and Throat Hospital, have served to corroborate these preliminary findings and have led to the following conclusions:

1. In eyes exhibiting clinical symptoms of narrow-angle glaucoma, the peripheral zone of the anterior leaf of the iris stroma usually is smooth and presents an unbroken surface.

2. In many instances of unilateral narrow-angle glaucoma, the iris of the normal fellow eye is pitted by well circumscribed peripheral iris crypts (fig. 2). These vary in size and number and are usually located just central to the limbus. The irises of some glaucomatous eyes may contain spaces which on first impression appear to be crypts, but which on more critical inspection are found to be covered by a thin translucent veil of iris tissue.

Peripheral iris crypts, otherwise desig-

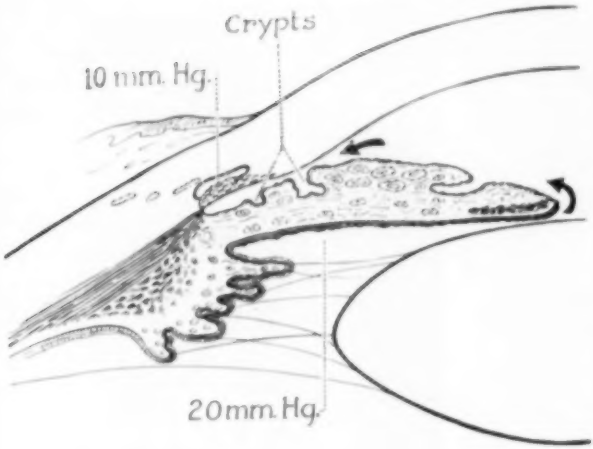

Fig. 1 (Posner). Schematic cross-section through anterior segment of eye with narrow chamber angle. A peripheral iris crypt situated at the entrance to the angle safeguards the eye from acute elevations of tension by maintaining communication between central and peripheral zones of anterior chamber. Were it not for this break in continuity of the surface of the iris, the peripheral zone of the anterior chamber would be cut off from the central zone by circumferential contact between iris and cornea at entrance to angle, the aqueous would be drained off, and the root of iris would be sucked toward the trabecula, blocking further outflow of aqueous.

nated as ciliary iris crypts, are reported by anatomists[6] to be a characteristic and almost constant finding. They are situated near the root of the iris, where the anterior leaf of the stroma is greatly attenuated. Since the crypts stop at the posterior leaf of the iris, their depth depends on the thickness of the anterior leaf. Their peripheral position accounts for the fact that they are generally not accessible to slitlamp examination. Occasionally, the crypts are unusually well developed in which case they may extend centrally for a sufficient distance to be visible with the slitlamp microscope. Gonioscopy offers no help in visualizing these crypts, because they are usually hidden from view by the last roll of the iris.

From these studies the impression was gained that eyes with narrow chamber angles in which peripheral iris crypts are not visible with the slitlamp may be subject to acute attacks of glaucoma. Conversely, eyes with well-developed peripheral iris crypts usually give no history of glaucoma and are not subject to elevations of tension even though the chamber angle is narrow. A peripheral iris crypt is particularly significant when it is fairly large and when it overlies one of the peripheral ridges in the anterior leaf of the iris. This ridge usually corresponds to the last roll of iris visible gonioscopically. A crypt in this location acts like an iridectomy to prevent closure of the angle by anterior suction on the iris, even though it does not extend through the entire thickness of the iris. It is important to search the entire circumference of the iris for the presence of these crypts, since a single crypt can be as effective as a large number of them in preventing acute glaucoma.

Variants which probably are functionally equivalent to crypts have been observed in some cases. In the normal eye of one patient with unilateral narrow-angle glaucoma a hole was present in the iris stroma about two mm. central to the limbus. This hole passed obliquely backward and upward and appeared to tunnel through the iris stroma to open into the periphery of the anterior chamber.

The sector atrophy of the iris which often follows acute congestive glaucoma may act in the same manner as a peripheral iris crypt. Atrophy of the iris stroma results from pressure necrosis of the corresponding sector of the iris. The atrophic sector is thinner than the rest of the iris and forms a depression in the general plane of the anterior surface of the iris. In order to prevent acute attacks the atrophy must extend into the angle of the anterior chamber. It has long been known clinically that sector atrophy of the iris is sometimes as effective as an iridectomy in

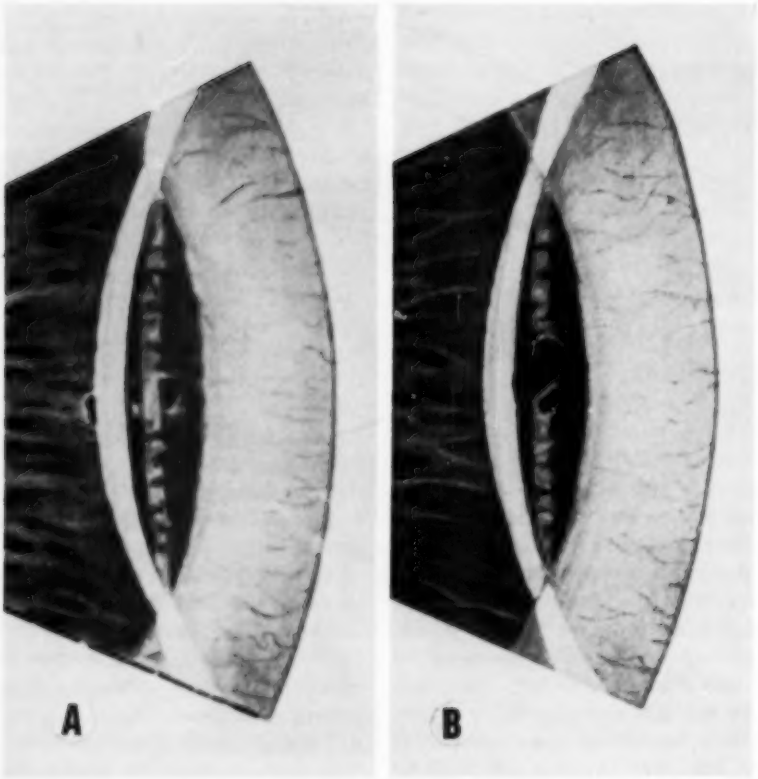

Fig. 2 (Posner). Appearance of iris of normal left eye (B) in a case of narrow-angle glaucoma of right eye. Iris contains a peripheral crypt at the 3-o'clock position. Gonioscopically, the angle is just as narrow as that of the right eye (A) which has suffered several noncongestive acute attacks of glaucoma during the past three years.

preventing future acute attacks.

In one 70-year-old man who had had an acute attack of narrow-angle glaucoma 15 years ago and had since been free of attacks without the use of miotics, sector atrophy of the iris extended beyond the entrance to the angle which was much wider in this sector than in the rest of the circumference.

More frequently, iris atrophy involves only the pupillary zone and does not prevent acute attacks. I recently saw a patient who had had three severe attacks of acute congestive narrow-angle glaucoma in the same eye. Atrophy of iris stroma was noted in three sectors involving the pupillary region, but none of the patches involved the periphery of the iris. Gonioscopically the angle appeared to be equally narrow along the entire circumference. Two days later the patient suffered another acute attack.

Other factors which affect the susceptibility of a narrow-angle eye to glaucomatous attacks are density of the iris stroma and the degree of development of radial and circular furrows. These markings of the anterior surface of the iris tend to become less pronounced with advancing age. This smoothening of the iris, coupled with decreasing depth of the anterior chamber usually associated with growth of the lens, may account for the increased frequency of acute glaucoma in the older age group.

Relation to Therapy

Therapy of narrow-angle glaucoma should be directed toward drawing the iris away from contact with the cornea. By exerting traction on the pupillary border the miotic drugs stretch the iris and diminish its forward convexity, known as "physiologic iris bombé." Miosis of the pupil is only incidental. While the action of miotics is generally beneficial, they may occasionally have a paradoxic action by precipitating an attack of glaucoma. This may occur when the stretching of the iris is insufficient to widen the entrance to the angle, while the ironing out of contraction furrows and of shallow crypts enables the iris to make watertight contact with the cornea. Deep iris crypts, though not apt to be obliterated by contraction of the pupil, may be displaced so as to impair their function as safety valves. Acute glaucoma caused by miotics has been observed occasionally after pilocarpine, but is more apt to occur after stronger miotics, and especially DFP. These tend to produce congestion of the ciliary body and iris with further narrowing of the chamber angle. I encountered several instances in which patients, who had had mild noncongestive attacks of glaucoma recurring for several years before treatment was instituted, developed severe congestive attacks within a short time after the glaucoma was diagnosed and miotic treatment started. It is a good rule not to prescribe miotics for prophylactic use in the normal fellow eye in the absence of a history indicative of recurrent elevations of ocular tension.

The action of the miotic in narrow-angle glaucoma is largely mechanical. Hence, if one-half or one-percent pilocarpine produces maximal or nearly maximal miosis without normalizing the tension, it is futile to try strong miotics. Strong miotics are especially contraindicated in noncongestive attacks because of the danger of producing congestion. Some patients who are controlled by miotics develop mild attacks when they neglect to use their drops. In two such patients, I found peripheral iris crypts opposite the limbus. It is possible that without the use of miotics, these crypts are displaced more peripherally where they cannot exercise their protective function.

The most conservative as well as the most effective means of preventing recurrences of acute narrow-angle glaucoma is a peripheral iridectomy. This view is currently accepted by most authorities. Reference has already been made to the striking similarity in action between the peripheral iridectomy and an advantageously placed iris crypt in preventing acute elevations of tension. My observations of iris crypts have strengthened my conviction that the iridectomy is the operation of choice in narrow-angle glaucoma, even if it has existed for many years, provided that the tension between attacks remains normal. It is only when the tension is consistently elevated or if several congestive attacks have already occurred that an iridencleisis becomes necessary. Clinical experience has shown that peripheral anterior synechias do not readily form unless the endothelial lining of the anterior chamber has been damaged. Such damage occurs either in the course of a severe congestive attack of glaucoma or as a result of uveitis or endothelial dystrophy. Cyclodialysis as a primary operation and without the presence of a coloboma is definitely contraindicated in any stage of narrow-angle glaucoma. Bangerter and Goldmann[7] have pointed out that after cyclodialysis the tension soon rises again and the eye is even more prone to acute attacks. From a study of the function of iris crypts, it may be readily seen that cyclodialysis does not act in the same sense as iridectomy in preventing iris block. On the contrary, by increasing the rate of outflow of aqueous through the periphery of the anterior chamber, it even favors the production of a pressure difference between the anterior and posterior chambers and thus increases the forward suction of the iris which is held responsible for the acute attack.

SUMMARY

1. For a more accurate evaluation of the prognosis in narrow-angle glaucoma, it is essential to consider the topography of the entire anterior surface of the iris and not merely the width of the chamber angle in optical section.

2. Peripheral iris crypts are partially penetrating holes at the outer fringe of the anterior leaf of the iris stroma. When well developed, the more centrally situated ones may be biomicroscopically visible.

3. They have been observed in those narrow-angle eyes which were free from glaucomatous attacks, and especially in the normal fellow eyes in cases of unilateral narrow-angle glaucoma.

4. Based on the "iris suction" hypothesis, closure of the angle sufficient to precipitate an acute attack of glaucoma presupposes not only the presence of a narrow angle, but also a continuous and unbroken surface of the iris where it comes into contact with the cornea. This makes possible a watertight seal when the iris is sucked forward toward the relatively low pressure region of the corneoscleral trabecula and the canal of Schlemm.

5. Iris crypts in this location may interfere with watertight closure of the entrance to the angle by permitting communication between the central and peripheral zones of the anterior chamber.

6. Peripheral iris crypts are believed to play an important role in safeguarding the eye with narrow chamber angle from acute elevations of tension. Conversely, their absence predisposes the eye to attacks of acute glaucoma.

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MYOPIA OF PREMATURITY*

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Myopia has been repeatedly associated with retrolental fibroplasia during the past five years[1] but myopia of prematurity has not yet been designated as a clinical entity nor have studies been reported which have elucidated the clinical nature or etiology of the abnormality. The purpose of this presentation is to discuss myopia of prematurity, to point out its onset, its relationship to the immature eye and retrolental fibroplasia,[2] and to discuss the possible mechanisms which may be responsible.

From April, 1950, to October, 1954, 462 premature infants have been examined serially. These infants were born in Jefferson

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TABLE 1

INCIDENCE OF PREMATURE INFANTS WITH NORMAL FUNDI AND THOSE WITH RETROLENTAL FIBROPLASIA ACCORDING TO BIRTH-WEIGHT GROUPS

Jefferson Davis Hospital and Private Hospitals, April, 1950 to October, 1954

Birth Weight (gm.)	Normal	Retrolental Fibroplasia	Total	Retrolental Fibroplasia (percent)
2,001–2,500	29	2	31	6
1,701–2,000	46	6	52	11
1,501–1,700	122	24	146	16
1,251–1,500	88	42	130	32
1,001–1,250	31	44	75	59
<1,000	10	18	28	64
TOTAL	326	136	462*	29

* 379 infants less than 1,700 gm. with 34% retrolental fibroplasia.
19 of these babies are blind. (5% less than 1,700 gm.).
9 have their best vision impaired (Cic. retrolental fibroplasia, grade 3).

Davis Hospital and in the private hospitals of Houston. The majority of the infants have been followed until six months of age, while those with ocular abnormalities have been followed over a longer period. Of the 462 prematures, 379 weighed less than 1,700 gm. at birth, 326 had normal eyes, and 136 had retrolental fibroplasia (table 1).

In 1950, it was noted that all premature infants had a high and fluctuating myopia. After this observation the least minus lens of the ophthalmoscope necessary to focus clearly on the retinal vessels at the disc margin was recorded at each examination. Recognizing that this method is an inexact one for determining the degree of myopia, considerable effort was made to determine the degree of error induced by accommodation on the part of the infant or the examiner.

A group of 45 infants were given atropine in the conjunctival sac daily during their hospitalization. These infants were examined weekly, or more often, and no difference was observed in the degree of or fluctuations of their myopia as compared with a simultaneously studied similar control group in whom atropine was not used. Approximately 10 infants have been retinoscoped with and without atropine and Cyclogyl,® hourly, daily, and weekly. The same high and fluctuating myopia was noted but it was slightly less than that recorded with the ophthalmoscope.

It thus appears that accommodation by the infant or the examiner during ophthalmoscopy is of little significance in the observed myopia of prematurity and the data obtained by this method are valid for comparison.

EARLY MYOPIA

Infants born with mature fundi, weighing more than 1,700 gm. at birth, tend to have a mild degree of myopia (approximately zero to −6.0 diopters), which fluctuates very little, and over a period of four to 10 weeks becomes relatively stationary near zero. At six months the majority of these fundi are seen with a plus-one to minus-three diopter lens.

The small infants weighing less than 1,250 gm. at birth have immature eyes and exhibit a myopia from −10 to −20 diopters, which over the ensuing weeks may remain high or fluctuate as much as 20 diopters. This fluctuation varies from one infant to another and has no consistent relationship to clouding of the vitreous. As the eyes reach maturity, there is a decrease in the degree of myopia and the fluctuations become less. Those babies with immature eyes at birth have more residual myopia at six months than their larger brothers (from −2 to −6 diopters), and it is approximately one year before they become relatively stable near zero.

RETROLENTAL FIBROPLASIA

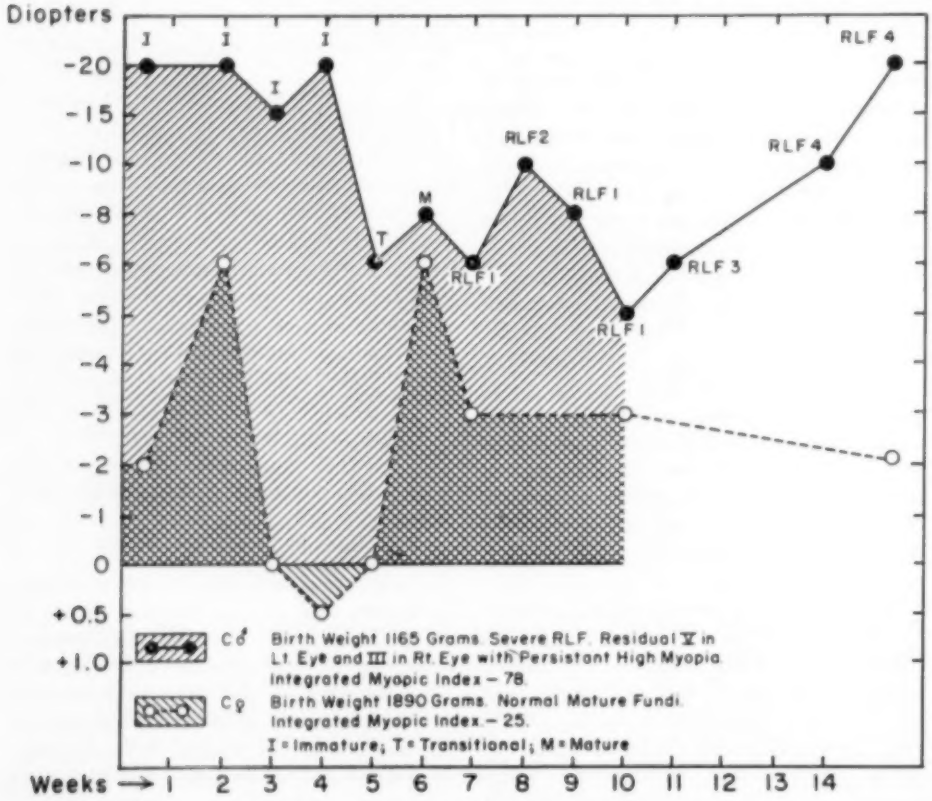
Premature infants who develop retrolental fibroplasia tend to have a higher degree of myopia during their first few weeks as well as during the acute disease. Likewise, as a generalization, the more severe the retrolental fibroplasia the more severe the preceding and concurrent myopia. Several infants who developed severe retrolental fibroplasia have been noted to have a very high and sustained myopia early (−10 to −20 diopters

for 10 weeks or more) with a gradual fall to near normal and a secondary rise to −10 or −20 between three to six months of age, which has been sustained now for two years or longer.

Analysis

In order to analyze the results statistically and thereby test the validity of impressions, it was necessary to find some means of adequately expressing the fluctuation as well as the degree of myopia seen during the neonatal period. Each infant's observed myopia was plotted on a semilogarithmic graph for the first 10 weeks after birth. (The semilogarithmic graph minimized the error inherent in the high minus dioptric power of the ophthalmoscope.) Using zero as the base line, the total area of observed myopia was measured with a planometer and the results expressed as an "integrated myopic index" (graph 1).

The myopic index was computed for 196 babies and the results tabulated according to birth weight and presence or absence of retrolental fibrop'asia (table 2). From the data obtained there is a significantly higher degree of myopia in the small infant weighing less than 1,500 gm. at birth, as compared with the large infants weighing more than 1,700 gm. at birth. Likewise, there is a significantly higher degree of myopia in the infants who subsequently developed severe retrolental fibroplasia as compared with those



Graph 1 (Fletcher and Brandon). Integrated myopic index.

TABLE 2

COMPARISON OF THE MEAN INTEGRATED MYOPIC INDICES IN PREMATURE INFANTS OF VARIOUS BIRTH WEIGHTS

(196 Cases)

	Birth Weight in Grams											
	<1500				1500–1700				>1700			
	No.	Range	Mean	St. Dev.	No.	Range	Mean	St. Dev.	No.	Range	Mean	St. Dev.
Normal	60	8 — 85	56.9	17	60	−12 — 77	42.3	16	19	15 — 75	39.6	16
Mild retrolental fibroplasia	17	31 — 91	62.1	17	9	33 — 90	63.9	18	2	40 45	42.5	4
Severe retrolental fibroplasia	25	29 — 96	68.4	17	4	36 — 77	53.7	17				

STATISTICAL ANALYSIS:

1. The standard error of difference between those infants <1500 gm. birth weight who developed severe retrolental fibroplasia and the infants >1700 gm. with normal fundi is 5. The difference between their myopic indices is 29, or almost six times greater than the standard error of difference and is therefore highly significant.
2. The standard error of difference between infants with birth weights less than 1500 gm. compared with infants of birth weight more than 1700 gm. is 4.2. The difference in myopia between these two is 17, or four times greater than the standard error of difference.
3. The standard error of difference between the infants with normal and severe retrolental fibroplasia fundi (less than 1500 gm. birth weight) is 4.1. The observed difference in myopia is 8.5, or twice the standard error of difference, which is significant.

of the same weight group who remained normal.

LATE MYOPIA

The majority of premature babies, when six months to one year of age, have small degrees of myopia ophthalmoscopically but as yet this ametropia has not been studied retinoscopically and its significance is not known.

It is striking, however, that almost all of the high myopia seen in our clinic during the past four years has been in infants who previously had acute retrolental fibroplasia (table 3). Of this group of 22 babies, 19 were part of the 136 acute retrolental fibroplasia cases followed from birth; an approximate incidence of 14 percent with residual high myopia. Two were not followed in their neonatal period but show the cicatricial lesions of retrolental fibroplasia in their fundi. Only one premature infant followed from birth is definitely known to have been free of acute retrolental fibroplasia, but this infant at present has a residual high myopia. This child has no known family history of myopia. At birth his eyes were immature, his myopia diminished to −1 diopters at three months, then rose to −8 diopters at 10 months where it has remained. With this one exception, all of our cases have had retrolental fibroplasia, most of them severe retrolental fibroplasia (table 4).

Ninety percent of the infants with high myopia weighed less than 1,500 gm. at birth (table 5). Seven of the 22 had sufficient data to calculate their myopic index and all were found to be above 65. There was a greater incidence in males than females and greater incidence in whites than Negroes,* facts of questionable significance other than the presence of greater immaturity in these instances.

* Seventy percent of the premature group studied were Negroes.

TABLE 3

LATE MYOPIA OF PREMATURITY

(22 cases seen)

Case No.	Gm. Birth Weight	Color	Sex	Acute Retrolental Fibroplasia		Myopic Index	Cicatricial Retrolental Fibroplasia		Myopia		Age	Method Determination	Assoc. Anomalies
				Right	Left		Right	Left					
1	1474	B	M	Not seen			3	3	−16	−16	4 yr.	Ret.	Esot.
2	1400	B	M	3	3	80	2	2	−20	−15	7 mo.	Oph.	
3	1075	W	M	3	3		2	2	−11	−11	4 yr.	Ret.	Esot.
4	1150	B	M	1	1	65	OK	OK	−15	−10	2 yr.	Oph.	
5	1125	B	M	1	1		2	2	− 3	− 8	18 mo.	Ret.	
6	1065	B	M	3	3	73	2	3	−10	−10	15 mo.	Oph.	
7	1480	W	M	3	3	90	OK	OK	−10	−10	2 yr.	Oph.	
8	1420	W	M	OK	OK		OK	OK	− 8	− 8	2 yr.	Oph.	
9	1100	B	M	3	3	96	2	2	−18	−18	2 yr.	Ret.	
10	1200	B	F	3	3	66	OK	OK	− 5	− 5	15 mo.	Oph.	
11	1240	B	F	3	3	66	OK	OK	− 4	− 4	15 mo.	Oph.	
12	1474	W	M	Not seen			2	2	− 4	− 4	15 mo.	Ret.	Esot.
13	1673	W	M	3	3		OK	OK	−10	−10	1 yr.	Oph.	
14	680	W	M	3	3		1	2	− 5	− 5	2 yr.	Ret.	Esot.
15	1370	W	F	3	3		2	3	−10	−10	6 mo.	Oph.	
16	1106	W	M	3	3		3	3		−11	2 yr.	Ret.	
17	975	W	F	1	1		OK	OK	− 6	− 6	2 yr.	Ret.	
18	1120	W	F	3	3		2	2	− 6	− 6	2 yr.	Ret.	
19	1680	W	M	2	2		OK	OK	− 6	− 6	1 yr.	Oph.	
20	1247	W	M	3	4		OK	OK	−20	−20	8 mo.	Oph.	
21	1021	W	M	3	3		OK	OK	−20	−10	7 mo.	Oph.	
22	1315	W	F	3	3		2	1	−10	− 8	9 mo.	Oph.	

DISCUSSION

In attempting to understand the mechanism for the myopia of prematurity, the eye may be considered embryologically. Much is known of the anatomy and histology of the developing eye but little is known of the physiology or biochemistry which may hold the answer to the problem.

To account for a fluctuating and high myopia one must consider that changes occur in the lens, corneal curvature, refractivity of the media, or axial length of the eye. Any one such condition or combinations of them may be responsible for this clinically observed phenomenon.

TABLE 4

CASES OF LATE MYOPIA OF PREMATURITY, CLASSIFIED ACCORDING TO ACUTE AND CICATRICIAL RETROLENTAL FIBROPLASIA OCCURRING IN INDIVIDUAL EYES

Acute Retrolental Fibroplasia		Cicatricial Retrolental Fibroplasia					
Stage	No. Eyes	Normal	1	2	3	4	5
OK	2	2					
1	6	4		2			
2	2	2					
3	28	11	2	12	3		
4	1	1					
5	0						
?	4			2	2		
TOTAL	43	20	2	16	5		

LENS

The fetal nucleus of the lens begins to develop about the third month and is complete near term. During the period of rapid development of the eye (sixth to eighth month), the lens is rapidly increasing in size and becoming more spherical. Changes in lens metabolism with changes in water content could be a factor in a fluctuating and increased myopia. The ciliary muscles and zonules are present, though not completely developed, and accommodation is possible. Two infants, approximately 1,500 gm. in weight, were retinoscoped and found to be

TABLE 5

RESIDUAL MYOPIA OF PREMATURITY: CASES CLASSIFIED ACCORDING TO BIRTH WEIGHT

Birth Weight (gm.)	Number
1,501–1,700	2
1,251–1,500	7
1,001–1,250	11
<1,000	2
TOTAL	22

accommodating, rapidly but infrequently, at least six diopters. This accommodation is probably of little significance in the observed myopia of prematurity but changes in curvature and position of the lens may be important.

Corneal curvature

Plastic mould casts of the corneas of premature infants have been obtained and diameters and curvatures measured. Small premature infants weighing less the 1,250 gm. have corneal diameters of approximately five mm. They increase in size very rapidly until around 2,000 gm. when the corneal diameter is nine to 10 mm. (adult is 11 mm.). This method of obtaining the radius of curvature was not sufficiently accurate so an attempt is being made to measure the dioptric power of corneas with the opthalmometer. As yet there are no available figures. On retinoscopy it was found that these infants have a rather high cylinder (two to five diopters), which changes in degree as well as in axis from day to day. The pressure of the lid retractor may be a factor in this.

From the available data and mathematical calculations, it seems quite feasible that changes in curvature of the rapidly developing cornea could explain the high and fluctuating myopia of prematurity. In the small premature eye a decrease in the anterior radius of curvature of only 0.4 mm. would increase the myopia 16 diopters. Whereas, in the adult (using Gullstrand's reduced eye) a similar decrease increases the myopia only three diopters (Appendix 1).

Changes in curvature of the cornea depend upon aqueous volume and the growth and elasticity of the cornea and sclera. Little is known of the volume of aqueous produced in the premature infant or of the capacity of the drainage system. Anatomically the ciliary body is well formed in the last trimester but the iris angle still is not fully differentiated. Maturity of this tissue is not complete until three to six months after term birth. From the embryologic point of view it is not unlikely that in the prematurely born infant with immature ocular structures, alteration of metabolism of the inner eye may result in either an excessive aqueous formation or a relatively inadequate aqueous drainage which may readily explain the abnormal stretching of the ocular coats and the resulting myopia associated with prematurity.

Refractive index

Keeney has stated that in newborn infants the refractive index of the media is higher than in adults[3] but there are no available data on the refractive index of the immature vitreous or aqueous. From the vitreous clouding that is present in the immature eye and those with acute retrolental fibroplasia, one would expect to find some increase in refractive index. An increase from 1.33 to 1.38 would be necessary, by itself, to increase the myopia in the premature's eye 16 diopters (Appendix 2). Variations in adult media are in the range of 1.336 to 1.338. It may be inferred from the enormous increase in volume of the developing eye (28th to 32nd week) that important metabolic processes are taking place which could result in a change in refractive index and which would count, at least in part, for the high and fluctuating myopia.

Axial length

According to Keeney[3] the length of the fetal eye increases from 14 mm. to 17 mm. during the last trimester. The coats of the eye are present but quite thin, incompletely developed, and highly elastic. Any changes in intraocular fluid would very readily be manifested by a change in ocular diameter, most likely in the axial diameter. In the theoretical premature's eye a posterior displacement of the retina one mm. would result in a myopia of approximately seven diopters (Appendix 3). This implies that a fluctuation in axial length of the developing eye of one to three mm. would be necessary to account for the observed myopia of prematurity. It seems quite possible that the volume

of a developing eye may fluctuate to this extent, depending upon its vitreous and aqueous mass.

Summary

Myopia of prematurity is associated with an immature eye. From the embryologic facts and mathematical probabilities there may be an underlying metabolic disturbance in the media of the eye producing changes in axial length, corneal curvature, and index of refraction. Any one or all of these combined could produce an increased myopia. This process, further altered by retrolental fibroplasia, results in a persistent high myopia. Such abnormalities in metabolism of the media of the developing eye may be conditioned by the infant's abnormal extrauterine existence.

Conclusions

The development of the eye in 462 premature infants, 136 of whom had retrolental fibroplasia, has been studied over the past four years. These infants were found to have a high and fluctuating myopia during the neonatal period, more exaggerated in the small infants with immature eyes and in those infants who subsequently developed retrolental fibroplasia. Myopia observed early in retrolental fibroplasia may remain as a residual of the disease.

The mechanism for the production of myopia in premature infants appears to be associated with the immature eye and the underlying metabolic disturbance in retrolental fibroplasia. There probably exists an abnormality in metabolism of the media of the developing eye influenced by the abnormal extrauterine existence of the premature infant.

2301 Maroneal Street (25).

Appendix

In order to analyze the optical properties of a premature eye, it is simple and adequate to construct a reduced eye (similar to that of Gullstrand), assume it to be emmetropic, and calculate the changes necessary to produce the observed myopia of prematurity.

A premature eye of approximately 14 mm. in diameter (1,000-gm. fetus) is assumed to have a posterior focal distance of 13 mm. and an index of refraction of 1.33. To find the other properties of this eye the following formulas are used:

$$(1)\ D = \frac{N-1}{r}$$

$$(2)\ F' = F \times N$$

$$(3)\ D = \frac{1}{F}$$

$$(4)\ D = \frac{N}{F'}$$

D = dioptric power of eye
N = index of refraction of media
r = radius of curvature
F' = posterior focal distance
F = anterior focal distance

The dioptric power of this reduced premature eye is

$$D = \frac{N}{F'} = \frac{1.33}{0.013} = 102\ D$$

The radius of curavture of the anterior surface is

$$D = \frac{N-1}{r} = 102 = \frac{1.33-1}{r}$$

$$r = 0.0032 \text{ or } 3.2 \text{ mm.}$$

(1) Changes in radius of curvature:

To calculate what change in radius of curvature in the reduced premature eye is necessary to produce the observed myopia of prematurity, compare a radius of curvature (r) of 3.2 mm. with a radius of curvature (r) of 2.8 mm.

$$D = \frac{N-1}{r} = \frac{1.33-1}{0.0032} = 102\ D$$

$$= \frac{1.33-1}{0.0028} = 118\ D$$

A decrease in radius of curvature of 0.4 mm. in the premature's eye will produce a myopia of 16D. Whereas, in Gullstrand's reduced adult eye this same decrease in radius of curvature produces only three diopters of myopia.

$$D = \frac{N-1}{r} = \frac{1.33-1}{0.0057} = 59\ D$$

$$= \frac{1.33-1}{0.0053} = 62\ D$$

(2) Changes in refractive index:

To produce the myopia of prematurity by change in the refractive index of the media only, an increase of 0.05 is necessary to produce 16 diopters of myopia.

$$D = \frac{N-1}{r} = \frac{1.33-1}{0.0032} = 102\ D$$

$$= \frac{1.38-1}{0.0032} = 118.7\ D$$

(3) Axial length:
An increase in posterior focal length from 13 to 14 mm. produces 7 diopters of myopia.

$$D = \frac{N}{F'} = \frac{1.33}{0.013} = 102 \text{ D}$$

$$= \frac{1.33}{0.014} = 95 \text{ D}$$

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THE ROLE OF THE PUPIL IN AMETROPIA

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In a simple optical system the aperture may be limited only by the lens or lenses themselves; but in a well-constructed, compound image-forming system, at least one diaphragm or stop with an opening—stop aperture—should be a carefully planned element. There may be one or more, p'aced in front of, behind, or between the lenses.

The purpose of the stop is to interrupt the rays that disturb the perfection of the image. The larger the aperture the greater the amount of light that can enter the system and the brighter the image, but with the likelihood of less definition. The size of a diffusion image depends on the size of the aperture; generally, the smaller the aperture the sharper the image. Also, by decreasing the size of the aperture and thus eliminating the rim rays, all the aberrations are diminished, more or less, and the depth of focus increased. The ideal aperture, therefore, will admit just those rays which are useful or effective in the formation of a bright and sharply defined image.

In the eye, the iris is the stop and the pupil is the stop-aperture of the optical system. In the normal eye the pupil is favorably located between the corneal system and the lens, close to a point which corresponds to what may be considered the optical center of the eye. In the aphakic eye it lies entirely behind the dioptric system, the cornea. The change in the location and in the number of the optical constants, together with the change in position of the pupil, even if the iris were intact, which is seldom the case after cataract extraction, produces a material effect on the imagery of the aphakic eye.

In most optical instruments and in normal human eyes, the apertures are circular, or approximately circular. Also, in nearly every instance, the principal axis of the system passes exactly or nearly exactly through the center of and perpendicular to the plane of the stop-aperture; but in human eyes the ophthalmologist must often take into consideration pupils of irregular shape and eccentric location.

The pupil, as seen in situ, is the virtual image by the corneal system. It is slightly magnified and apparently displaced forward. The pencils of light in the object-space which enter the eye are limited not by the real, but by the apparent pupil, the pupil of entrance.

The entrance-pupil in the average normal eye varies between about two mm. and nine mm. in diameter—from about f/11.3 to f/2.5 aperture speeds. Because of the variation in the size of the pupil, together with the remarkable adaptability of the eye, light can be utilized over a tremendous range of intensities, from less than a single foot-candle to 10,000 or more foot-candles.

Diagrammatically, every point of the ob-

ject is the apex of a pencil of effective incident rays. The base of these pencils is formed by the stop-aperture—the entrance-pupil—which is the common base of all of the pencils of effective rays. Whatever the shape and size of the entrance-pupil, so will be the shape and size of the base of the pencil of effective rays—the rays which go to form the retinal image.

The direction of the rays after refraction is determined by the dioptric system—the pupil can have no effect on the direction of the rays in the emergent pencil. If the fovea should lie in a plane through f (fig. 1) as in an emmetropic eye or an ametropic eye exactly accommodated or one properly corrected with a lens, provided there is sufficient illumination, neither the size, shape, number, nor position of the pupil or pupils would interfere with distinct vision. The same is true for an opacity in the optical media—cornea, aqueous, lens, or vitreous not far from the lens.

It is not uncommon to find 6/5 visual acuity in ragged, irregular and/or displaced pupils, the result of disease, traumatism, or surgery. From this it can be inferred that an operator, from the standpoint of the ultimate usefulness of an eye, should choose whenever possible to give a large pupil, however irregular or displaced, especially in the absence of normal transparency.

In eyes of low visual acuity because of cloudy media the extra amount of light admitted into the eye by a large pupil is of great importance. Generally speaking, large pupils do not interfere with the highest visual acuity. In mydriasis and in irideremia, per se, perfect vision can usually be given with the proper lens for both far and near.

While the human eye possesses even more faults than a spheric lens, the aberrations associated with a large aperture do not interfere with clear central visual acuity. The retina is peculiar in that it is sensitive to sharp images over only an extremely small portion in the vicinity of the fovea. Even though a clear image were made to extend over a large area, as in a well-designed camera, it would be wasted on the less sensitive peripheral retinal elements. The rim rays are not important in the formation of the part of the retinal image which is useful for distinct central visual acuity. If it were not for these facts the vision would always become blurred whenever the pupils would be dilated.

If the retina were in d (fig. 1) as in hypermetropia, or in d′, as in myopia, the image would be large and blurred in direct proportion to the distance from the focal plane. In any variety of ametropia, that is, in any optical system out of focus, the diffusion image assumes the geometric form of the aperture—erect when the retina lies closer than the focal plane and inverted when it lies farther away. When there are two apertures, as in Scheiner's experiment, two diffu-

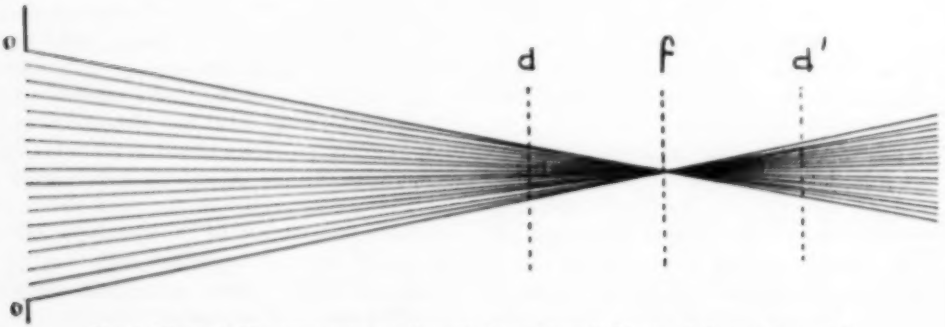

Fig. 1 (Cowan). The emergent rays, through the aperture O O′, are all directed toward f.

sion images are formed. Medial obstructions will be included in the diffusion image. This is the reason that certain opacities in the media, which are a great source of annoyance to a patient with uncorrected ametropia, may be imperceptible to the same patient wearing his proper glasses. In a properly adapted eye only when an opacity in the vitreous is close enough to the retina to produce a geometric shadow on the retina can the patient be conscious of its presence.

When the focus, in the case of d or d′ (fig. 1), is corrected by the accommodation or with the proper lens, the image is moved backward or forward to the fovea (it becomes smaller and sharper in either case), and the vision is made clear and distinct. When, in subjective refraction, on adding a lens, the patient states that the object appears smaller but sharper, it means that the addition is indicated. The patient should be told that neither apparent distance nor size of the object it to be considered. The only criterion in subjective testing is sharpness of definition.

Contraction of the pupil will sharpen the visual acuity in an ametropic or unaccommodated eye by excluding the peripheral rays, thereby decreasing the size of the diffusion images. With a very small pupil (must not be small enough to produce annoying diffraction) or stenopaic pinhole aperture, the diffusion images can be so reduced that they are within the angular size of the resolving power of the eye, and the visual acuity will then be as sharp as though the eye were exactly in focus, provided there is sufficient light.

With enough illumination a small pupil is a distinct advantage in uncorrected ametropia or in any poorly focused eye. It can hide a material refractive error. But it is of hardly any benefit at all in a properly focused eye. A stenopaic dot aperture will improve the vision in any form of refractive error, provided there is sufficient light; but it can only lower, never improve, the visual acuity in emmetropia or in any exactly corrected or accommodated eye. In the determination of the ocular refraction the importance of the effect on the retinal image by a lively pupil must not be overlooked. The static refraction can certainly be more accurately measured with a dilated, fixed pupil. From both the scientific and practical standpoints no method of refraction, objective or subjective, can be absolutely reliable with an active pupil. Both the accommodation and the activity of the pupil should be kept under control.

The pencil of light contains one ray—central ray, guide ray—which passes through the center of the image in the focal plane (fig. 2), L′. It coincides with the visual axis

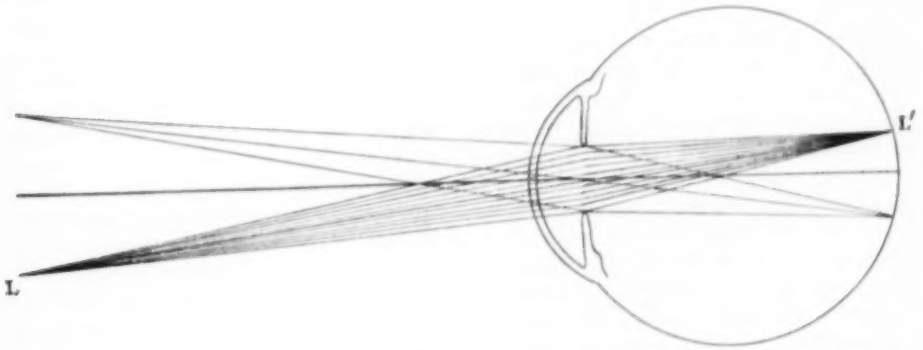

Fig. 2 (Cowan). The direction of the guide ray L L′ will not change with size, shape, or number of pupils as long as the conjugates L and L′ are unchanged.

when the eye is exactly focused. In the adapted eye neither the size, shape, nor location of the pupil can change this. The visual axis, coincident with the guide ray, need not pass through the center of the pupil. In certain cases it may not pass through the aperture at all. It must proceed in exactly the same way uninterruptedly regardless of the position of any obstruction or stop. It will pass through an opacity in the cornea or lens, or through an opaque iris when the pupil is displaced.

As long as the retina lies in the focal plane the eye must not change its direction with an eccentric pupil, or even more than one pupil, or it will not receive the image at the fovea; the visual axis cannot deviate no matter where the pupil or pupils are placed, whether central or peripheral. Both visual axes of the two eyes, if emmetropic or properly corrected, must, regardless of the positions of the pupils, be directed to an object in order to obtain binocular single vision.

The surgeon need not hesitate, from the standpoint of the ultimate usefulness of the two eyes together, to locate an artificial pupil for the clearest opening, regardless of its regularity or position. These facts must not be forgotten in the measurement of squint. Also, to be properly centered, the pole or so-called center of a spectacle lens should be adjusted with regard to the visual axis, not the pupil.

In the case of a diffusion image—ametropic or unaccommodated eye—the central or guide ray of the incident pencil of light passes through the center of the pupil wherever it is. In uncorrected ametropia or in an unaccommodated eye, the central ray does not coincide with the visual axis unless the visual axis happens to pass through the center of the pupil. This eye, therefore, would tend to deviate in a direction along the guide ray. It is possible for a deviating, ametropic eye with an eccentric pupil to straighten out on being properly corrected.

The pupils are small in very young infants and in elderly people. They are contracted during convergence, accommodation, and sleep. In children and up through adolescence they are relatively large. The pupils are larger in myopia and smaller in hypermetropia, than in emmetropia. These size differences become less and less after the age of 20 years until, after the age of 40 years, the pupils are much the same—they are all small. Unequal pupils, however, are not found in anisometropia or in antimetropia. This, of course, is because the accommodation is always equal and the dilatation and contraction of the pupils are the same in a pair of normal, healthy eyes. Therefore, when there is a difference between the refractions of the two eyes, only one eye at a time can possibly see an object at a certain distance distinctly. The size of both pupils will correspond to the size for the adapted eye.

As has been stated, on decreasing the size of the pupil, the diffusion image is made smaller, the depth of focus is increased, and the retinal image is made more distinct but with less brightness. For this reason test objects should be sufficiently illuminated to allow enough light to pass through the small opening in the disc during a pinhole test of the visual acuity. This is a test of the form sense, not brightness.

Small pupils are a contributing factor in the comparatively low power of dark adaptation and poor scotopic vision sometimes found in aged persons, and this is particularly true in the case of patients with glaucoma who are using miotics. These people require exceptionally good illumination, not only because of the small pupils but also because of the lessened transparency of the media which is a normal condition in the aged. Obviously elderly persons with a comparatively small region between largest pupil and smallest pupil require a longer time for dark or light adaptation than young ones.

On the other hand, because with very small pupils with increased focal depth and consequent large region of comparatively clear vision, such a patient must find it hard to discern a difference between moderate or

even considerable additions to or subtractions from his correcting lens. This is the exasperating patient who, after you have spent considerable time in the determination of a fairly high refractive error, is likely to take off the glasses and read the test objects almost as well without them.

The constant use of the eyes under poor or too bright light with uncorrected errors of refraction, even very small errors, can produce exaggerated symptoms of asthenopia as a result of the antagonism between the size of the pupil in response to the light and the size which tends to conform with the accommodation and convergence.

Relatively high intensities of illumination are required for adequate brightness of the retinal image in uncorrected or undercorrected hypermetropia, to compensate for the small pupil associated with the accommodation for all distances, but particularly for close work, when the added effect of convergence comes into play. In such cases the constant contraction of the sphincter of the iris during the entire working day, both for far and near, is in itself sufficient cause for pain and discomfort; but in dim light the tendency to produce a conflict between the pupil large enough to admit sufficient light, and the contraction which is a necessary accompaniment of accommodation, adds to the discomfort.

In uncorrected myopia, with relaxation of the accommodation and the associated wide pupil, the size of the diffusion image is increased. Contraction of the pupil by bright light would improve the visual acuity; but the increase of the accommodation evoked by the contraction of the pupil would add to the dioptric power of the eye and further blur the retinal image.

In the case of a young person with uncorrected myopia bright light is a disadvantage for distance vision. Myopes, generally, can see better for near without their glasses because with relaxed accommodation not only is the retinal image larger, but the comparatively wide pupil allows more light and, therefore, a brighter image than with a corrected eye. Presbyopes with myopia can obtain a certain improvement in visual acuity for distance in bright light by contracting the pupil without, at the same time, bringing accommodation into the act. The same effect is produced in young persons with a pinhole aperture.

In young persons with uncorrected low-grade hypermetropic or myopic astigmatism and with the ability of the accommodation to bring into focus first one and then the other focal line of Sturm's conoid, the associated, constantly changing size of the pupil, however slight, is an important factor in the production of asthenopia.

In a young, healthy emmetropic eye the proper size of the pupil for the brightest and, at the same time, clearest image possible is the result of the nice timing and co-ordinated reaction of the iris to light, accommodation, and convergence. If this relationship is disturbed by uncorrected ametropia, faulty accommodation, and convergence, or by improper lighting conditions, the result is fatigue of the iris and consequent symptoms of asthenopia.

1930 Chestnut street (3).

SULFONAMIDES AS A CAUSE OF TOXIC AMBLYOPIA*

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Loss of vision due to toxic effects on the optic nerves by the sulfonamides rarely occurs. These substances probably have an extremely low degree of toxicity for human nervous tissue. The four cases of optic neuritis to be presented appear to be linked to the use of various sulfonamides.

Toxic substances nearly always affect both eyes. Usually some vision returns if the offending agent is removed. If the poison, toxin, or other responsible agent is correctly identified, treatment is facilitated. Unequivocal identification is often difficult or impossible. Diagnosis is hampered because adequate tests for such substances are lacking, because it is difficult to secure a history of exposure to an unsuspected toxic substance, and because a similar clinical picture may be produced by a large variety of causative agents. Since pathologic studies are seldom possible, the ophthalmologist relies almost entirely on clinical findings.

Uhthoff[1] was the first to divide the toxic amblyopias into two large groups. His first group characteristically is associated with bilateral central or cecocentral scotomas with only slight involvement of the peripheral fields. Peripheral neuritis may be associated. The substances responsible have a selective affinity for the papillomacular bundle of the optic nerve. Tobacco, lead, inorganic arsenic, methyl alcohol, ethylhydrocupreine hydrochloride (Optochin®), carbon disulfide, thallium, and presumably the sulfonamide drugs are members of this class of substances. His second group of toxic amblyopias is characterized by peripheral contraction of the visual fields and sometimes also central scotomas. Peripheral neuritis rarely is associated. Quinine, salicylates, Filix mas, and organic arsenic compounds commonly cause such a clinical picture.

The sulfonamides rarely produce toxic lesions of nerves. We could find only a few reports of such instances in the entire literature.

Bucy,[2] in 1937, reported a 16-year-old boy who had chronic osteomyelitis of the ilium and who lost vision in both eyes while receiving sulfanilamide. He was given the drug in three courses. Administration during the first two courses was stopped because headache, cyanosis, diarrhea, and a choking sensation ensued. When a single tablet of the drug was given to begin the third course, severe loss of vision occurred a few hours later. Central scotomas reduced vision to 6/200 in the right eye and 4/200 in the left eye. Each optic disc was edematous. Vision returned to normal in seven days.

Ahmed,[3] in 1945, reported two cases of optic atrophy presumably caused by sulfonamides.

His first patient was an eight-year-old boy on whom a mastoidectomy had been done. A sinus developed postoperatively, so three sulfonamide tablets were given three times daily for one month. One morning he awakened completely blind. Papilledema was present in each eye. After eight days, perception of light returned and on the 10th day he detected movements of the hand. On the 20th day he counted fingers. After five weeks, the visual acuity of each eye was 6/12.

Ahmed's other patient was a 28-year-old woman who had puerperal sepsis. She received 16 sulfonamide tablets daily for four days. As her vision became hazy, administration of the drug was stopped; however, by the 10th day all vision, including perception of light, was lost and there was no

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recovery. This author ascribed the good results in the first patient to prompt administration of nicotinic acid. He regretted the delay of several days in starting this treatment in the second patient.

Hollis and Baty[4] reported on a six-week-old infant ill with colon-bacillus meningitis who received sulfathiazole and who later had "blindness due to optic atrophy." The child recovered her vision. An article by Rauch and Krimsky[5] pointed out that visual involvement occurs sometimes among children who have meningitis caused by Bacterium coli anaerogenes even when not treated with sulfonamides.

Scuderi[6] suggested that sulfapyridine and sulfathiazole caused the unilateral blindness of his patient, who had otogenous meningitis.

Bieter and associates[7] found that chickens are especially prone to have toxic peripheral neuritis when they receive sulfonamides. These substances produced injury to the nervous system in chickens in degree according to the following ascending series: sulfanilamide (mildest), sulfapyridine, sulfathiazole, sulfamethylthiazole, sulfanilyl dimethylsulfanilamide, and sulfaphenylthiazole (most severe).

The pathologic changes in mild involvement consisted of slight condensation of myelin in the peripheral nerves with swelling of the axons and similar mild changes in the myelin sheaths of the posterior and lateral regions of the spinal cord. Severe involvement was manifested by extensive condensation, fragmentation, and vacuolization of the myelin, with swelling, loss of staining properties, irregularities and fragmentation of the axons of the peripheral nerves.

The spinal cord showed chromatolysis of the nerve cells, with swelling and fragmentation of myelin and axons; in the brain, the nerve cells became pyknotic and extensive proliferative endarteritis was present, with partial or complete occlusion of the smaller vessels. These authors reported on two patients who had peripheral neuritis.

Robb,[8] Brown and Herrell,[9] and Bannick and associates[10] described peripheral neuritis caused by sulfonamides.

In the 10-year period from 1944 to 1953, inclusive, four patients at the Mayo Clinic had visual loss from toxic amblyopia related to sulfonamide therapy.

Report of cases

Case 1

A four-year-old girl experienced the onset of acute tonsillitis in November, 1953. She received an initial dose of 300,000 units of procaine penicillin G (duracillin); a total of 3.5 gm. of a suspension of sulfamerazine, sulfamethazine, and sulfadiazine (cremotres) was given during the next three days. As her condition was much improved, the medication then was discontinued. Two days later, evidence of recurrence was present; the mother, a nurse, gave a total of 1.5 gm. of cremotres during the next two days. The child blinked excessively and complained of pain in her eyes on the latter day; she was less active than usual that evening. She awoke the next morning (December 2nd) completely blind in both eyes.

Examination showed dilated nonreactive pupils with no perception of light in either eye. Papilledema of the right optic disc measured 1.5 diopters and that of the left was 2.0 diopters. There was no exudate or hemorrhage. The veins were engorged. Slight ischemic pallor of each optic disc was present. Results of general and neurologic examinations were completely normal in all respects. Sulfonamides were not detectable in the blood on the day after the onset of blindness.

Treatment consisted of administration of 15 mg. of thiamine daily. Two days later the papilledema had lessened to 1.0 diopter in the right eye and 1.5 diopters in the left eye. The papilledema continued to recede.

On December 11th the pupils reacted slightly for the first time since the onset of blindness. She detected objects to the right but not to the left. Improvement continued slowly. By December 21st the pupils were small and reacted promptly, but the patient could not yet identify objects.

Use of nicotinic acid, 25 mg. three times daily, was started. On December 28th she could recognize pictures on test cards at one meter. The papilledema was nearly gone and the optic discs began to show more pallor.

By January 4, 1954, the vision of the right eye had improved to counting fingers and that of the left to 6/30. Mild pallor of each optic disc was present; the papilledema was gone. Vision gradually improved. On March 10th the vision was 6/12 in each eye; there was more pallor of each disc. In July, 1954, the visual acuity was 6/6 in each eye but the optic discs were chalk white. The caliber of the retinal vessels was normal.

Case 2

A 10-year-old boy became ill about one month

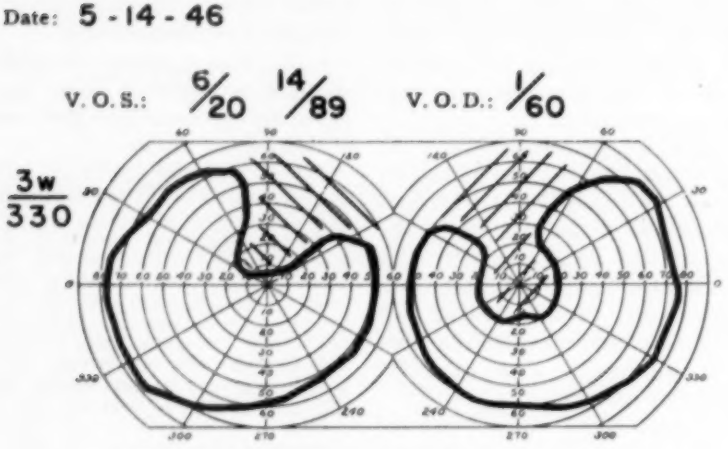

Fig. 1 (Taub and Hollenhorst). *Case 2.* Visual fields.

prior to coming to the clinic. The diagnosis of measles was suspected and the home physician gave him 14 tablets of a sulfonamide (type not known) for a total dose of 7.0 gm. in two days; all medication was then stopped. Three days later the child noted impaired vision. He was seen three weeks later at the clinic.

Visual acuity of the right eye was 1/60 and that of the left eye was 6/20. Examination of the visual fields showed a central scotoma that broke through to the superior nasal periphery in each eye (fig. 1). The optic discs had good color but the retina at the lower portion of each disc had a milky color, especially on the right. This was diagnosed as the absorbing phase of bilateral optic neuritis. As the patient left our care shortly afterward, his course could not be followed. Several letters of inquiry to the parents went unanswered.

CASE 3

A 47-year-old woman underwent cholecystectomy in October, 1944. After operation she received 3.5 gm. of sulfathiazole prophylactically; its use was discontinued after five days because of nausea. She did well until October 18th (16 days after operation), when the left eye became painful; the next day the vision of this eye failed.

Visual acuity was 6/7 in the right eye and 1/60 in the left eye. A large dense central scotoma was present in the field of vision of the left eye, with considerable contraction of the peripheral field (fig. 2*a*). The left optic disc was elevated one diopter by papilledema. A blood test showed an absence of sulfathiazole; results of urinalysis for lead were within normal limits. No abnormalities were found on neurologic examination.

By October 31st the vision of the affected eye had improved to 6/12 without treatment (fig. 2*b*). Visual acuity on November 14th was 6/6 but there was mild pallor of the optic disc. Further improvement was noted at the time of dismissal on December 5th (fig. 2*c*).

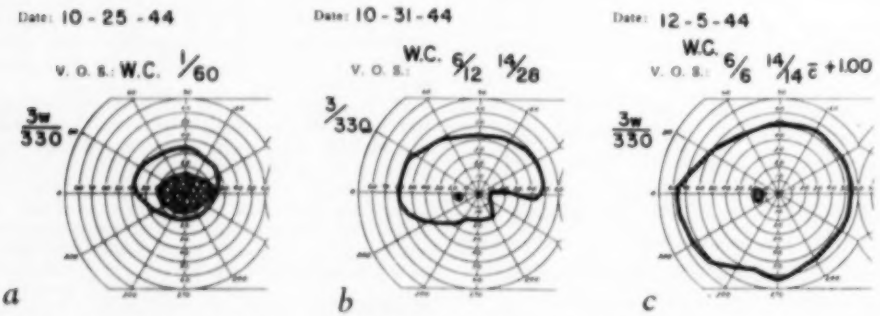

Fig. 2 (Taub and Hollenhorst). *Case 3.* Visual fields.

CASE 4

A 58-year-old woman had a rectosigmoidal resection for carcinoma of the rectum in September, 1948. Preoperatively and postoperatively over an 18-day period (September 11th to 29th) she received 108 gm. of sulfasuxidine; during a two-day period (September 18th and 19th), she received 2.5 gm. of sulfadiazine. She sat up for the first time on September 30th, at which time she had a severe occipital headache. On October 1st she awakened with poor vision in each eye.

Although her vision was limited to counting fingers, the pupils had normal reactivity and the ophthalmoscopic examination showed no abnormalities. The following day the vision had improved to 6/60 in each eye. The ocular fundi were still normal. The central scotomas are shown in Figure 3*a*. No treatment was given. By October 8th the visual acuity had improved to 6/20 in the right eye and 6/30 in the left. On October 12th the vision of the right eye was 6/12 and that of the left eye was 6/10 (fig. 3*b*). She was dismissed on that day. She died three years later of liver metastasis.

COMMENT

The total amount of the sulfonamide preparations given to the first three patients was not great, being 5.0, 7.0, and 3.5 gm., respectively; the fourth patient received 110.5 gm. The first patient was given a combination of sulfamerazine, sulfamethazine, and sulfadiazine, the second received an unknown sulfonamide, the third was given sulfathiazole, and the fourth got sulfasuxidine and sulfadiazine. Sulfonamides were not detectable in the blood of the first and third patients after visual loss occurred; the test was not done on the other two.

Loss of vision occurred in the first patient on the sixth day of administration (two days after resumption of treatment), in the second patient three days after completion of two days of therapy, in the third 11 days after completion of five days of therapy, and in the fourth two days after completion of 18 days of treatment. Only the fourth patient had an absence of papilledema.

The tendency in all instances was definitely toward recovery of vision. The vision of the first patient returned to normal in about four months, that of the second patient could not be followed, that of the third returned to 6/6 in one month, and that of the fourth improved to 6/12 in the right eye and 6/10 in the left eye 12 days after the onset of the ocular difficulty.

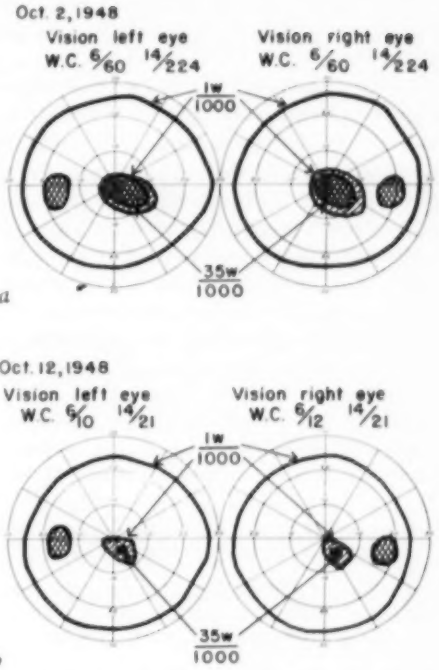

Fig. 3 (Taub and Hollenhorst). *Case 4.* Visual fields (tangent screen).

Because of an acute infection (tonsillitis) in the first patient and the question of measles in the second, the possibility of bilateral optic neuritis on the basis of encephalitis was entertained but signs of involvement of the central nervous system were absent. None of the patients had peripheral neuritis.

It is questionable whether or not the fourth case should be included as an instance of bilateral toxic neuritis. The central scotomas in each eye were almost identical in shape and in their position in the visual field. The pupils reacted well. The improvement in each eye also was almost identical. This suggests some type of bilateral lesion of the occipital lobe, either thrombotic, embolic, or metastatic, rather than toxic optic neuritis. However, the case was included even though the diagnosis was not clear.

In view of the tremendous world-wide consumption of sulfonamides, the few reports of damage to the optic nerve we have collected apparently indicate that these nerves are extremely resistant to toxic involvement from such substances. Whether these phenomena are truly on a basis of toxicity or are manifestations of hypersensitivity cannot be ascertained at present. Because the doses given to the first three patients were small, one is impelled to postulate hypersensitivity as the offending mechanism.

Treatment other than discontinuance of administration of the sulfonamide apparently is not necessary, as the three patients whose condition could be followed recovered spontaneously. With the exception of Ahmed's patient, all patients reported on in the literature recovered their vision.

Summary and Conclusions

Four patients who had visual loss from toxic amblyopia related to sulfonamide therapy were seen during a 10-year period at the Mayo Clinic.

Toxic neuritis involving the optic nerves can result from the systemic use of the sulfonamides. The loss of vision is probably on the basis of an individual idiosyncrasy or allergy to the drug rather than overdosage.

The tendency is toward complete recovery of vision. Treatment probably is not necessary.

The Mayo Clinic.

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MICRORADIOGRAPHIC STUDY OF THE INNER WALL OF SCHLEMM'S CANAL*

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Although the outer wall of Schlemm's canal with its aqueous veins is anatomically well known, this knowledge is not valuable for its inner wall—the one separating the canal from the anterior chamber. Most theories about the outflow of the aqueous humor through the scleral trabeculae toward the canal of Schlemm are based upon different hypotheses, but none of them seems to be proved with certainty.

If some think (Schwalbe, 1870) a direct communication exists by a system of trabecular clefts, others (Rochon Duvigneaud, 1893) agree with either an osmotic process for noncolloidal substances (Friedenwald, 1936), or a diffusion process (Kronfeld, 1932), or a filtration process (Fortin, 1942), or an ultrafiltration process.

Sondermann (1932), Theobald (1934), and Thomassen and Bakken (1951) postulated that there exists a direct communication. For Seidel (1918) the pores of the filter should have the same size as those of a collodion-membrane (three percent). One finds the same divergent opinions concerning the presence of endothelium on the level of the trabecular system, which, if it exists for some authors is absent for others.

Even those accepting the existence of endothelium do not agree with its anatomic repartition; for Gutmann (1895) it only covers the walls of the clefts, which constitute the communications between the anterior chamber and Schlemm's canal, for others it establishes an uninterrupted and nonperforated covering which is, however, not impassable (Leber, 1895) because colloidal substances can find an outlet either by slipping between the cells or by phagocytosis.

This divergence of opinions stimulated our interest to study the anatomic relations of the inner wall of Schlemm's canal by microradiography, a method we have already utilized for the study of the vascularization of the eye and the optic pathways (1954).

I. Preparation of the specimens

We used monkey and human eyes. The intracameral injection of contrast substances was performed in vivo on monkeys, immediately after death on men. Results were identical in both cases.

First the Rh monkey was administered a general anesthesia by intracardiac injection (three or four cc. of pentothal); afterward, by puncture of the anterior chamber, 0.2 or 0.3 cc. of aqueous humor were collected.

With the needle left in place, immediately and under a minimal pressure, 0.3 to 0.4 cc. of contrast substance (Thorotrast or Angiopac) was injected (0.1 cc. more than the aspirated quantity of aqueous humor).

Once the needle was removed from the anterior chamber, the point of puncture was closed by thermocoagulation, preventing an outflow of the injected emulsion. The anterior segment of the globe was amputated either directly after the intracamerular injection, or after half a minute, or after one or two minutes. The crystalline lens, iris, and ciliary body were removed, in order to retain only cornea and sclera. Then the sample was irrigated in three successive baths of physiologic serum for a few minutes and finally fixed in the following solution.

Drug	Parts
Formol	8
Alcohol (saturated with picric acid)	6
Acetic acid	1
Chloroform	1

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In men, we proceed in the same manner as in monkeys, immediately after or, at latest, a quarter of an hour after death. We used only normal eyes of patients whose ages ranged between 40 and 60 years.

After amputation of the anterior segment of the eye, the corneoscleral section was cleaned from every vestige of iris and ciliary body and cut into two parts by an incision along the vertical meridian. With a von Graefe knife, a small circular incision was made about the whole length of the ring of Schwalbe, in order to push the cornea down toward the sclera. After locating Schlemm's canal with the binocular microscope, we prepared, with a razor blade, thin slides of the scleral trabeculae and of Schlemm's canal itself.

Instead of utilizing the cameral way, we injected in another series of experiments, the contrast substances directly into Schlemm's canal, in human eyes removed immediately after death. The injection of opaque substances was generally followed by an injection of air.

II. Microradiographic technique

In order to permit the microscopic study of the pathways of outflow of a fluid, the technique chosen must satisfy three criteria: (1) Be specifically selective for this liquid; (2) possess a sufficient power of definition which is proportional to the details studied; (3) permit a spatial reconstruction of the system which is to be put in evidence.

By judicious application of X rays of long wavelength, and by the use of an emulsion of high resolution power, the injection of a canalicular system by a radiopaque substance permits obtainment of images which are microscopically visible. For this reason, this method, which utilizes radiologic optics and is ruled by its laws, was selected for the present study. By substituting selected opaque substances, which satisfy determined physicochemical conditions, for the fluid in its precanalicular phase, the radiologic method permits penetration of the intimate mechanism of the outflow pathways.

Characteristics of the microradiogram

Solution of the radiologic and photographic problems

1. Obtaining of contrasted images

The choice of the quality of the X ray beam, which is an important factor in the problem of contrast, must consider:

A. *Selective absorption.* The presence in the preparation of a substance of high molecular weight which renders the canalicular system opaque, achieves an important local absorption, and gives the method its selective character.

B. *Size of the detail studied.* In the present study, the definition which is necessary, is frequently of the order of five to 10 microns. However, in certain cases, very fine opaque structures (one micron) must be brought into view.

C. *The character of the emulsion.* All emulsions having a high power of resolution possess an elevated "gamma" and are thus favorable to the obtaining of greatly contrasted images.

Since the radiologic problem is a matter of the selective study of structures or canalicular systems injected with a substance of high absorption power, it is relatively simple; with soft X rays, a relatively penetrating radiation can be achieved.

Until recent years, the production and utilization of X rays of long wavelength was not possible because of important technical difficulties. The invention of tubes with Beryllium windows has permitted the use of this new type of radiologic investigation. We know that these windows allow the passage of rays of relatively long wavelength (up to four to five Angstrom units).

2. Obtaining images of fine detail

In order to permit direct microscopic study, or after enlargement by microphotographic apparatus, the microradiogram must be sharply defined.

A. *Resolution power of the emulsion.* Using emulsions without a reinforcing screen, only blur due to the grain of the

emulsion is present. Commercially, there are several types of emulsions whose resolution powers vary between 500 and 1,000 lines per mm. We used the Lippman (Gevaert) emulsion (800 lines per mm.), and occasionally the emulsion "maximum resolution" of Kodak (more than 1,000 lines per mm). Like all emulsions of very fine grain, this film is characterized by a very slow sensitivity, thus necessitating a considerable exposure time. This emphasizes the advantage of having a greater sensitivity to X rays than to radiations of the visible spectrum. Moreover, the developing can be controlled and prolonged developing time causes no fogging.

B. *Blurring due to movement.* The long duration of the exposure time makes imperative absolute immobilization of the X-ray bundle with respect to the preparation-film relationship. This can be obtained only by mechanical solidification of the different elements.

C. *Geometric blurring of the image.* Due to the laws of radiologic optics, geometric blurring is of great importance. The value of the umbra and the prime importance of the penumbra in the image will be discussed later.

Description of the Equipment

Our microradiographic unit (generator and tube) provides great convenience in handling (fig. 1).

A. Generator

The generator is in the same container as the high voltage transformer and the transformer used for heating the filament.

In both instances, the primary coils are fed by variable transformers; this permits a continuously variable range of 0 to 50 kv. maximum and 0 to 35 ma.

B. Tube (fig. 2)

We use a Machlett A2 tube with iron target and beryllium window. It is known that the intensity of the continuous spectrum emitted by an X-ray tube is proportional to the atomic number of the element which is used at the anode.

Fig. 1 (François, Neetens, and Collette). The microradiographic unit.

The intensity is low in this case since the atomic number of iron is only 26. However, the iron target emits characteristic lines of high intensity and great wavelength ($K_{\alpha 1}$: 1.936 Å; $K_{\alpha 2}$: 1.932 Å).

The intensity of these characteristic lines increases with the voltage, but the wavelength remains constant. Therefore, in the low voltage range, the intensity of the continuous spectrum will be negligible when compared to characteristic radiation. The

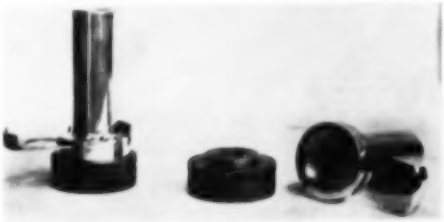

Fig. 2 (François, Neetens, and Collette). The tube.

latter, however, is soft and rapidly absorbed by air. This makes it necessary to use a short focal length in order to take full advantage of the intense monochromatic radiation.

In this study, the optimal voltage is 12.8 kv; under this condition, the intensity emitted is 20 ma. This tube is equipped with a one-mm. focus.

C. Film-holders (figs. 3 and 4).

The film-holder has been designed to permit the coverage of a circular field 25 mm. in diameter. The minimal source to object distance is 13.5 cm. Long exposure is necessary and requires that all parts of the system are firmly joined together. The film-holder (fig. 3-III, IV, and V) is fastened to the tube through a number of intermediary elements. First an adaptor (fig. 3, VI) is screwed into a circular hole bored in the cover of the film-holder. The intermediary piece accompanies the film-holder when it is filled; it is provided with a shutter which, when closed, protects the film from luminous radiations; it is opened only when the assembled apparatus is fixed to the tube, in such a manner that there is no obstacle to the radiation during the taking of the film.

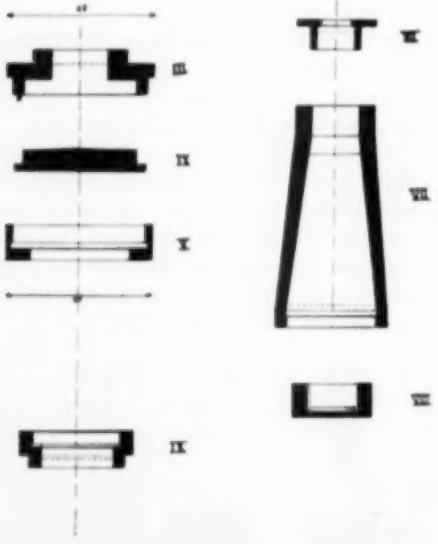

Fig. 3 (François, Neetens, and Collette). The film-holder.

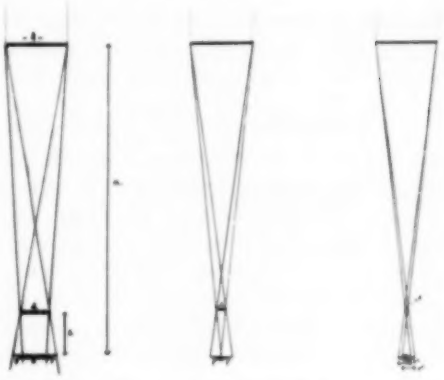

Fig. 4 (François, Neetens, and Collette). The film-holder.

Mounting the specimen

There must be a close contact between the film emulsion and the sample. The latter is never completely dry; a nonhydroscopic support separates it from the film. We usually put the sample between two sheets of Styrafoil, 1/1,000 inch thick. The upper sheet provides the close contact required when the film-holder is closed. The sample is removed from the fixing solution immediately before being X rayed. The excess fluid is drained off but the preparation remains moist throughout all manipulations. This is important because dessication may produce a change in volume and some motion during the exposure.

Opaque substances

In microradiography, the selective absorption can be achieved by diverse types of compounds: those of bismuth, lead, silver, gold, thorium, and iodine.

In the present study, we used Thorotrast and Angiopac. These colloidal suspensions, which satisfy the criteria of opacity and ability to fixate, are distinguished by absorption being proportional to the atomic num-

ber and by a variable diameter of their particles.

Thorotrast (Heyden Chemical Corporation), a stable colloidal suspension of thorium dioxide, is the ideal opaque substance because of its radiologic absorption and the diameter of its particles (less than 1/10th of a micron). To determine the "threshold" of the diameter of the outflow orifices and ducts, we used a calibrated opaque substance composed of particles of increasing diameter and the substance selected was Angiopac (Union chimique belge), a colloidal suspension of ethyliodostearate, with particles having quite uniform diameters varying from 1.0 to 4.0 μ.

We verified the particle-size of the two suspensions used in our experiments (Angiopac, No. 126 and No. 149) : 0.1 cc. of the suspension is diluted in 40 cc. of distilled water : one drop of this dilution is placed between plate and lamella and examined with a microscope equipped with a micrometric ocular. In this way we were able to determine that a majority of the particles of a given suspension had a constant diameter; the average of three measurements of Angiopac No. 149 gave a size of 1.5 μ; when that of No. 126 gave 2.25 μ.

It should be emphasized here that after injection of Angiopac of 2.25 μ into the anterior chamber, there is striking resistance to the outflow of the suspension.

Limits of the method: Calculation of geometric blur

The relative values of umbra and penumbra constructing a radiologic image may be calculated by using four basic conditions: size of the object and size of the focus, and focus-film and object-film distances.

Geometric reconstruction (fig. 4) shows after Bellman that, for $d > b/a \cdot f$ the picture is composed of umbra and penumbra. For $d < b/a \cdot f$, the picture contains only penumbra. Umbra's limit's value will be: $d = b/a \cdot f$.

The average formulas permitting evaluation of the relative importance of umbra and penumbra are:

$$U = a \cdot d - b \cdot f/a - b$$
$$P = b/a - b \cdot f$$

One can see, that for: $d < b/a \cdot f$ the picture is constructed by a superposition of dimnesses when one can delineate an overlapping of each other.

In this case: $m = a/a - b \cdot d$

In the composition of the picture whose value is $p + m$, m depends on the size of the studied structure but p is independent of it.

In the latter, there is no relation between the size of the object and the radiologic image.

The smallest structure will be of the size of p.

It is obvious that the contrast will be very weak.

Consequently, in the study of very small structures, it is absolutely necessary that the object-film distance should be as short as possible.

To illustrate the limits of the method Table 1 gives examples where, for a focus-film distance of 13.5 cm. (which is an ordinary value in our experiments) and for different very small opaque structures, the object-film distance corresponding to the minimal value of the umbra ($d = b/a \cdot f$) is calculated. Table 1 also shows the value

TABLE 1

To illustrate the limits of the method

Diameter of the Studied Patterns	Value of b for $d = \frac{b}{a} \cdot f$	Value of b for $d > \frac{b}{a} \cdot f$ when $U = \frac{75}{100} \cdot d$
1μ	135μ	33.77μ
2μ	270μ	67.60μ
3μ	405μ	101.47μ
4μ	540μ	135.40μ
5μ	675μ	169.38μ
10μ	1,350μ	340.05μ

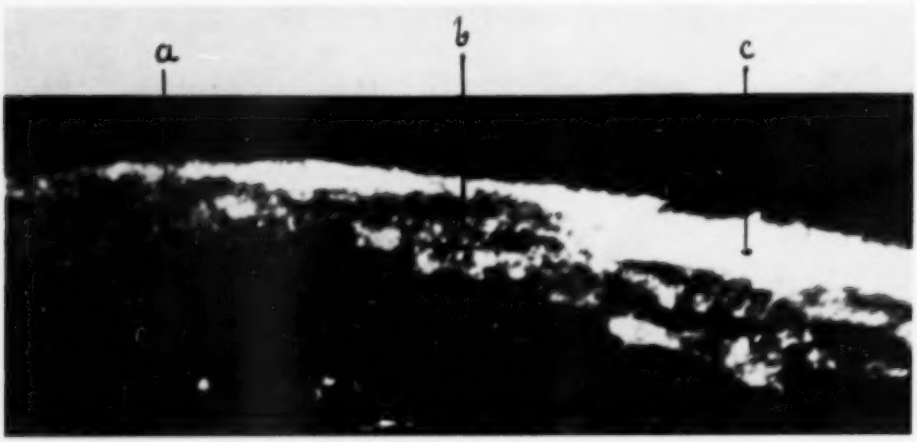

Fig. 5 (François, Neetens, and Collette). (Or. ×80.) (Man.) Injection of Thorotrast into the anterior chamber. Inner wall of Schlemm's canal. The very oblique slice from inside toward the outer aspects shows, from left to right, the trabecular pattern (a), that becomes more regular and obvious in the center, where appear numerous white spots (b); the latter establish the emptying of short ducts in the canal itself, which draws out into white opaque homogeneous stripes (c).

of "b," when obtaining an image whose relative values of umbra and penumbra will be sufficient: (Umbra = 75 percent of the value of the object).

When, because of the thickness of the sample, the distance "b" is too great to obtain sufficient definition, it is necessary to make "a" as great as possible. Practically in this case we work with a focus-film distance of 45 cm. Under those conditions, the exposure time is greatly increased and the X-ray beam will be weak in characteristic radiation compared to the continuous spectrum.

III. Results

The obtained results are identical in men and Rh monkeys.

After injection of contrast substance into the anterior chamber (figs. 5, 6, 7, 8, and 9) the microradiographs of the most inner

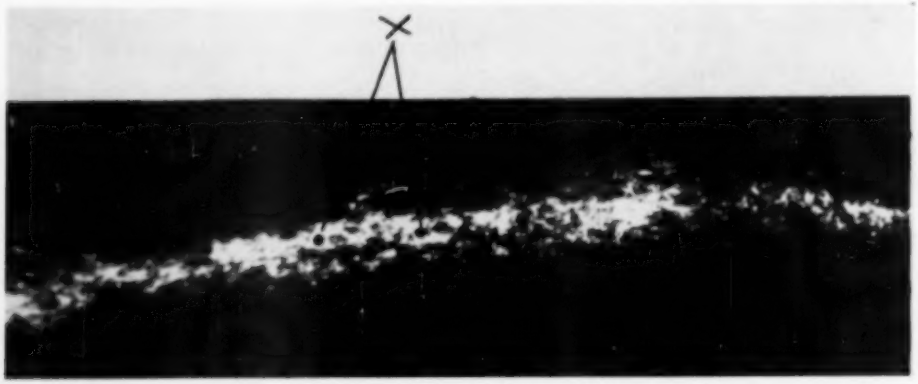

Fig. 6 (François, Neetens, and Collette). (Or. ×70.) (Man.) Injection of Thorotrast into the anterior chamber. Inner wall of Schlemm's canal. The numerous white spots indicate the region of emptying of the ducts in Schlemm's canal (x).

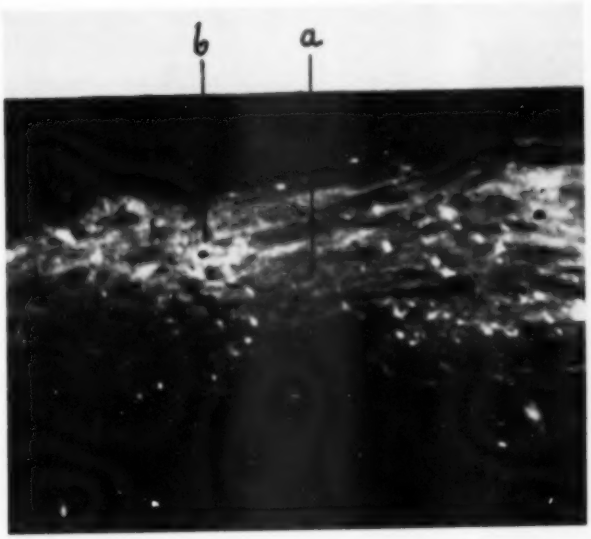

Fig. 7 (François, Neetens, and Collette). (Or. ×52.5.) (Man.) Injection of Thorotrast into the anterior chamber. Inner wall of Schlemm's canal and middle part of the trabeculae. Trabecular pattern quite obviously drawn out (a); some white characteristic spots (b) indicate the inner wall of Schlemm's canal.

part of the scleral trabeculae show irregular, blurred patterns, slightly dense or slightly opaque (penumbra). On the level of the middle part of the trabeculae one can find the same patterns but their outline becomes more regular and their opacity more obvious. On the level of the inner wall of Schlemm's canal, white, regularly rounded, or slightly oval spots predominate and there are also barely opaque, minute stripes.

This description is not based upon pictures obtained by superposition but upon direct pictures from each part taken separately and upon views from oblique sections.

After injection of the contrast substance into Schlemm's canal itself (figs. 10, 11, 12, and 13), the findings are the same as those described, undoubtedly due to an artifice, produced by injecting air after the injection of the Thorotrast. The air repels the substance and cleans the wall and permits obtaining of clear pictures.

Following injection into Schlemm's canal, the number of white spots is considerably diminished and numerous small stripes, delicate, tortuous and mostly radial, may be found. These stripes are not found after injection of Thorotrast into the anterior chamber. Their significance is still uncertain, however.

The pictures we obtained from the inner and middle parts of the scleral trabeculae resemble those seen after injecting Thorotrast under the skin, where the contrast substance follows the tissue clefts to be finally absorbed by the lymphatics. On the level of the scleral trabeculae we obtained first, on the side of the anterior chamber, blurred patterns showing numerous excessively narrow clefts in a loose tissue where the fluid was quite diffuse. Then we observed a more definite structure, quite systematically constructed presenting larger and more obvious clefts; at the end on the level of the inner wall of Schlemm's canal we found very short ducts which empty into the canal.

These findings would seem to show that the flow of aqueous humor from the anterior chamber to Schlemm's canal is neither by osmosis nor by diffusion. Indeed, osmosis is a rapid process which permits a fluid to pass from a region with lower concentration to one with higher concentration. In our experiments, instead of a real solution, we used a colloidal suspension and in osmosis we should have obtained pictures re-

Fig. 8 (François, Neetens, and Collette). (Or. ×190.) (Man.) Injection of Thorotrast into the anterior chamber. Inner wall of Schlemm's canal and trabecular system. The latter shows quite numerous small clefts (a) slightly opaque and hazy. The canal itself is indicated by a large homogeneously white band (b).

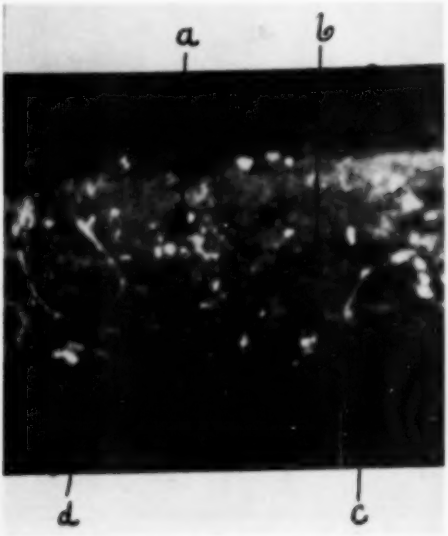

Fig. 10 (François, Neetens, and Collette). (Or. ×75.) (Man.) Injection of Thorotrast into Schlemm's canal; inner wall. The white spots (a) indicating the emptying of the ducts into the canal is diminished; the trabecular pattern is quite clear (b). Existence of white canalicular stripes (c) that meet with white spots along their course (d) or that are interrupted on the level of one of these spots.

producing a complete and homogeneous opacity. On the other hand, diffusion is a much slower process, which should have given completely opaque pictures.

Conclusions

The first conclusion to be drawn from our observations is the existence of a direct

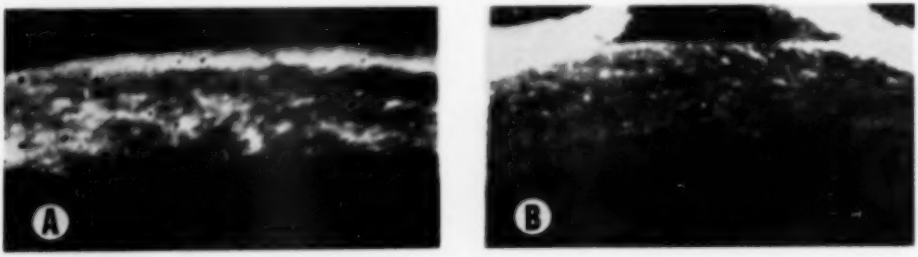

Fig. 9 (François, Neetens, and Collette). (Or. ×59.) (Monkey.) Injection of Thorotrast into the anterior chamber. Inner wall of Schlemm's canal. (A) Inner wall of Schlemm's canal itself. (B) Trabecular pattern. These pictures are strikingly similar to those obtained in men (figs. 6 and 8).

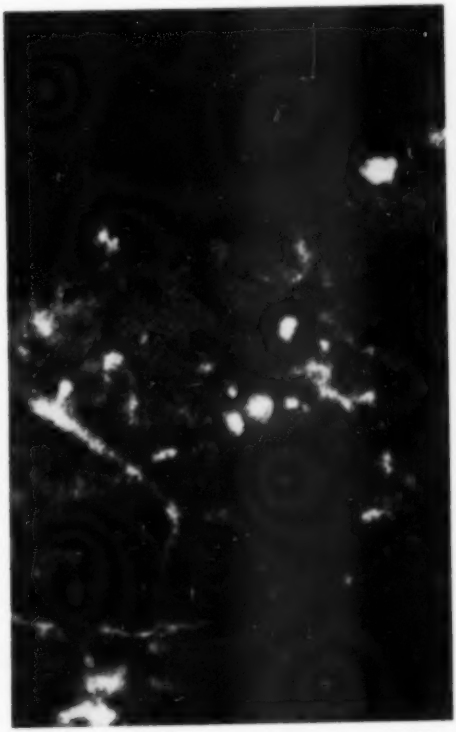

Fig. 11 (François, Neetens, and Collette). (Or. ×195.) (Man.) Enlargement of section of Figure 10. Note the high degree of clearness of this picture.

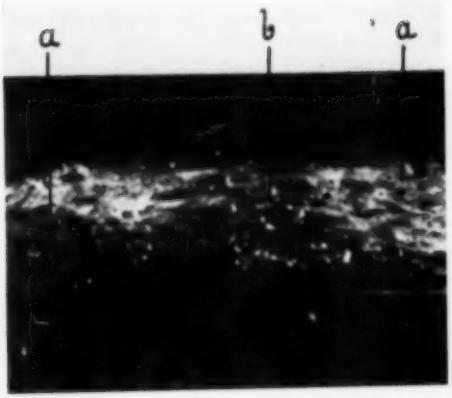

Fig. 12 (François, Neetens, and Collette). (Or. ×75.) (Man.) Injection of Thorotrast into Schlemm's canal. Outer part of the scleral trabeculae. The picture is identical to that obtained after injection into the anterior chamber. Note the trabecular system quite clearly drawn out (a) and some white spots, characteristic for the inner wall itself (b).

communication between the anterior chamber and Schlemm's canal.

The second conclusion concerns the existence, on the level of the scleral trabeculae, of a system of ducts and clefts which empty by orifices or pores into Schlemm's canal.

The third conclusion regards the diameter

Fig. 13 (François, Neetens, and Collette). (Or. ×75.) (Man.) Injection of Thorotrast into Schlemm's canal. Inner part of the trabeculae. The fine reticular system is clearly pointed out (x).

of these orifices of the inner wall of Schlemm's canal, orifices which we found to be greater than 1.5 μ and smaller than 2.25 μ.

Indeed:

1. Thorotrast with a particle size of nearly 0.1 μ. passes immediately and very easily.

2. Angiopac, with a particle size of 1.5 μ. passes after about 15 seconds, thus more slowly than Thorotrast.

3. Angiopac, with a particle size of 2.25 μ. does not pass at all.

These conclusions have recently been confirmated by the still unpublished studies of Huggert who determined the diameter of the pores of the inner wall of Schlemm's canal in men and of the scleral trabeculae in rabbits with suspensions of chromic phosphate and with bacterial suspensions, of different sizes and different concentrations. He found:

1. The upper margin for particles of chromic phosphate that pass through the scleral trabeculae of the rabbit eye lies between 1.2 μ and 2.4 μ. The corresponding values for human eyes were found to be 1.2 μ and 1.5 to 4.0 μ.

2. Tests with Bacillus prodigiosus demonstrated that the average size of the pores is 1.1 μ in the rabbit and 1.5 μ in the human filter.

3. Tests with Sarcina and Gaffkya strains showed the largest sized pore in the rabbit eye to be about 1.6 μ and more than 2.0 μ in human eye.

Summary

After injection of Thorotrast or Angiopac into the anterior chamber of the eye, or directly into Schlemm's canal and after study of the microradiographic patterns obtained, we come to the following conclusions:

1. A direct communication exists between the anterior chamber and Schlemm's canal.

2. On the level of the scleral trabecula there is a system of clefts which empty by orifices into Schlemm's canal.

3. The diameter of these orifices measures more than 1.5 μ and less than 2.25 μ.

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THE EFFECT OF SUCCINYLCHOLINE ON INTRAOCULAR PRESSURE*

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INTRODUCTION

In the past three years a new muscle-relaxing agent, succinylcholine, has come into such popular use in general anesthesia that at the present time it is rarely missing from among the drugs on the anesthesia tray. This popularity is the result of the many favorable qualities of the drug.[1-3] Succinylcholine has a potent myoneural blocking action. Its course is very rapid. A dose sufficient to produce flaccid paralysis of the skeletal musculature or relaxation for intubation or bowel replacement is effective within 20 to 40 seconds after intravenous injection, and recovery occurs in from one to three minutes. Because of the rapid hydrolysis of the drug into inert metabolites, the dose may be repeated as often as needed during a single procedure. Succinylcholine is thus very easily controlled, which would seem to make it most attractive to the eye surgeon, as a substitute for curare.

From various reports it is already being used occasionally in eye operating rooms at the discretion of the anesthesiologist. Although no accidents have been reported, the results of the work to be described herein indicate that, because of a peculiar effect of the drug, which results in a rise in intraocular pressure, succinylcholine should not be used in intraocular surgery.

Succinylcholine is chemically two molecules of acetylcholine joined at the alpha-methyl groups. It has been known for many years. Hunt and Taveau studied its effects in 1911.[4] It was re-examined in 1949 by Bovet in Italy,[5] as well as by Walker in England,[6] and Castillo and de Beer in the United States,[7] when all were examining compounds having 10 atoms between their nitrogen groups, this structure having been hypothecated to give powerful myoneural blocking action.

Succinylcholine's action at the myoneural junction resembles that of acetylcholine. It is classed as a depolarizing agent. While its exact mechanism is not clearly understood, it is thought to depolarize the motor end-plate and cause it to remain depolarized, because, unlike acetylcholine, it is not rapidly destroyed by the true cholinesterase of the cell; therefore, it probably remains in the vicinity of the motor end-plate until it rediffuses into the blood stream, where it is hydrolysed in the presence of the serum (pseudo-)cholinesterase. Unlike curare, its action is not inhibited but actually prolonged by the anticholinesterases such as physostigmine.[8]

While making a series of observations to compare the effects of curare, decamethonium and succinylcholine, Hofmann and Holzer, at the University of Graz in 1953, reported that succinylcholine raised intraocular pressure.[9] In a series of volunteers under no anesthesia, they observed rises in intraocular pressure as high as 18 mm. Hg, following the administration of the drug. Under general anesthesia with pentothal and nitrous oxide, the pressure increases which they observed were generally lower, of the order of four to eight mm. Hg. Under ether anesthesia they reported a rise of 10 to 14 mm. Hg. Hofmann and Holzer also observed, and regarded as most important, the fact that, coincident with the rise and maintenance of intraocular pressure, the eyes rotated into a divergent position and remained fixed, and that mobility was restored

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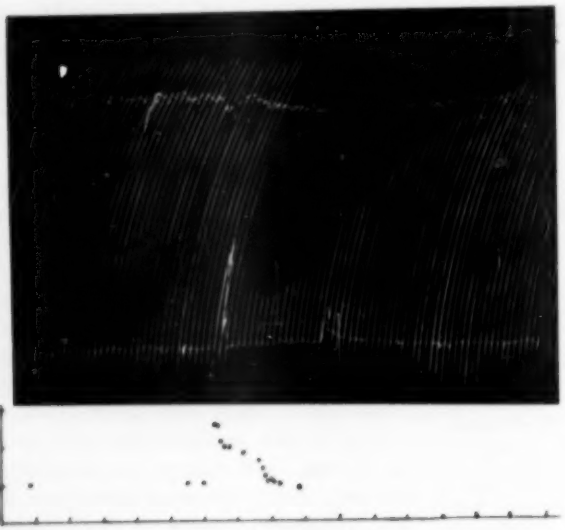

Fig. 1 (Lincoff, et al.). Effect of intravenous injection of 0.1 mg./kg. succinylcholine chloride in the cat. Upper record—carotid blood pressure. Middle record—response of gastrocnemius muscle to electrical stimulation of the sciatic nerve (single maximal square wave pulses at 10 sec. intervals). Lower record—Schiøtz tonometer readings in mm. Hg. At first arrow succinylcholine was injected and at the second arrow, a similar volume of 0.9 percent NaCl was injected. Time—minutes.

at the same time as the pressure dropped. This suggested to them that the increase in tension was caused by contraction of the extraocular muscles.

Experimental studies

In order to verify and extend these observations, a series of experiments on animals was undertaken at the Wellcome Research Laboratories, and observations were made on 75 electroshock patients, 10 general surgical patients, and three patients undergoing enucleation of the eye at New York University-Bellevue Medical Center.

In the work on animals, the effect of succinylcholine on skeletal muscle was examined by the usual methods[8, 10, 11] in order to evaluate the activity of the drug. Healthy adult cats were anesthetized with 35 mg./kg. of nembutal, injected intraperitoneally. Tracheal cannulas were installed to facilitate aeration when needed. An electrode was fitted to the sciatic nerve and the foot of the animal was attached to a stylus which recorded the twitch of the gastrocnemius muscle produced by electrostimulation of the sciatic nerve. An intravenous injection of 0.1 mg./kg. of succinylcholine* regularly caused a 90-percent loss of twitch force within 90 seconds. Recovery consistently occurred within three to four minutes (fig. 1).

Next, the muscular depression indicated by loss of kick was correlated with intraocular pressure. Tensions were measured both by a Schiøtz tonometer and by direct cannulation of the anterior chamber, the cannula being connected to a Sanborn electromanometer. The latter method served to standardize the tonometric readings. This was necessary, of course, if more than qualitative use of the tonometer was to be made, because the scale of the standard tonometer is based on a foot-plate design matching the corneal curvature of the human eye and is in error when the instrument is used with the flatter curvature of the cat cornea.

In the anesthetized cat, 0.1 mg./kg. of succinylcholine gave a consistent rise in intraocular pressure (fig. 1). Eight to 12 seconds after the intravenous injection, ocular pressure began to rise rapidly. Within 10

* In both the animal experiments and those on human subjects, Anectine brand succinylcholine was used.

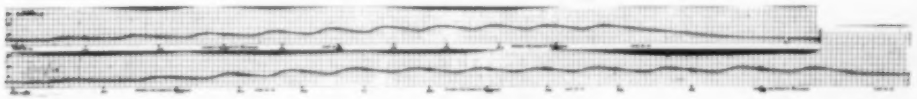

Fig. 2 (Lincoff, et al.). Effect of repeated injections of small doses of succinylcholine chloride on intraocular pressure in cats. Direct cannulation of anterior chamber. Upper record—repeated 0.003 mg./kg. doses as indicated by arrows. Lower record—dosage as indicated by arrows: first eight doses—0.004 mg./kg., doses 9 and 10—0.006 mg./kg., and doses 11 and 12—0.008 mg./kg. Pressure recorded in mm. Hg. Time: 10 sec. bar shown in upper left corner (2.5 mm./sec.).

to 20 seconds after the injection, a maximum pressure 12 to 18 mm. Hg above the initial intraocular pressure was obtained. The rise persisted for 30 seconds and then fell very gradually, returning to the initial level in about three minutes.

From Figure 1, it can be seen that while skeletal muscle is undergoing relaxation, intraocular pressure, contrary to expectations, is increased. This is not a precise inverse relationship, however, because the peak of the rise in ocular tension precedes maximum depression of the skeletal muscle, and the intraocular pressure recovers prior to the return of skeletal muscle tone.

It was found that 0.003 mg./kg. was the minimum dose which would produce a measurable rise in tension in the cats. Subsequent doses of 0.003 mg./kg., when administered just as the tension began to fall (in about 15 seconds), exerted a cumulative effect, causing a further rise in tension of the same height.

This steplike progression could be continued with administration of additional 0.003 mg./kg. doses, until a maximum tension of 12 to 18 mm. Hg was reached. Further administration of succinylcholine after the maximum tension had been reached, served only to sustain the rise in tension (fig. 2).

The same effect was seen with 0.004 mg./kg. doses and, increasing the dose, after the maximum level had been reached, likewise did not result in a greater pressure rise, but only in a longer maintenance of the maximum level.

Hofmann and Holzer, who in every case in human subjects administered doses large enough to cause the maximum rise in tension (0.0714 to 0.2280 mg. succinylcholine/kg.), concluded that the duration of the pressure increase, but not the amount of the increase, depended on the dose.

As already shown, however, experiments with smaller doses indicate that when submaximal doses are used, the *amount* of increase also bears a quantitative relationship to the dose (fig. 3).

Finally, an attempt was made to determine the process by which succinylcholine effected the observed rises in intraocular pressure. From the nature of the response, a steep and relatively immediate rise, it was felt that its cause must be mechanical. It seemed exceedingly unlikely that any changes in osmotic relationship or secretory activity could be manifested so quickly. Moreover, the relatively quick recovery also supports the concept that mechanical forces are responsible for changes in intraocular pressure. Therefore, the effects of hydrostatic forces and external forces, that is, arterial and venous pressure and the extraocular muscles, were considered.

1. *Arterial pressure.* It is generally thought that sudden changes in arterial pressure are dampened to a minimum before reaching the end vessels of the globe.[12] It did not seem likely, therefore, that a change in arterial pressure, if it occurred with succinylcholine, could be transmitted through the arteriolar endings and into the vascular bed of the eye. Further, the weight of evidence indicated that only extraordinary doses of succinylcholine (200 times the dose re-

quired for respiratory paralysis) raise blood pressure.[9] However, as there have been conflicting reports on the activity of succinylcholine on blood pressure,[13] experiments were run to correlate any blood pressure change that might occur with the observed rises in intraocular pressure.

The femoral artery of a cat was cannulated, 0.1 mg./kg. of succinylcholine was injected intravenously, and simultaneous observations were made on arterial blood pressure, intraocular pressure, and the power of the gastrocnemius to respond to electrical stimulation of the sciatic nerve.

Either no rise or a very small rise in arterial pressure (attributable to saline effect) was seen, coincident with the usual rise in intraocular pressure (fig. 1).

2. *Venous pressure.* It seemed more likely that the sudden change in intraocular pressure might be related to a rise in venous pressure. It is reliably reported that sharp increases in venous pressure are instantly transmitted to the globe, probably by obstructing venous return.[14] The jugular vein of a cat was cannulated, and 0.05 mg./kg. of succinylcholine was injected intravenously. The venous pressure, intraocular pressure, and kick response were simultaneously recorded.

The venous pressure was found to rise 2.4 mm. Hg coincident with the maximum rise in intraocular pressure. While it was not thought that this venous pressure rise was large enough to be the sole cause of the observed rise in intraocular pressure, it seemed possible that it might be a contributing factor.

3. *Anoxia.* Since succinylcholine is known to depress respiration, anoxia also might be a factor. The following simple experiment was, therefore, made: After determining the sensitivity to succinylcholine of the intraocular pressure of an anesthetized cat, the trachea was clamped for 90 seconds while intraocular pressure recordings were being made. Although a slight rise of about 4.0 mm. Hg occurred (fig. 4), this rise was so much smaller than that which results from a 0.05 mg./kg. dose of succinylcholine, that it was felt that anoxia had not played any significant part in the ocular response to succinylcholine.

4. *Extraocular muscles.* It is well known that contraction of the extraocular muscles is attended by a sharp and immediate rise in intraocular presure. This is the type of rise produced by succinylcholine. Therefore, from the first, a response of the extraocular muscles to the drug seemed a likely solution.

It will be recalled that Hofmann and Holz-

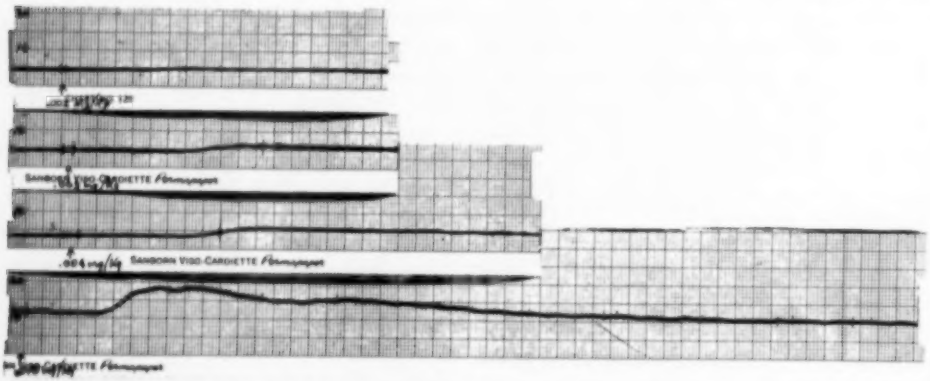

Fig. 3 (Lincoff, et al.). Effect of dose on response of cat intraocular pressure to intravenous injections of succinylcholine chloride. Upper record, 0.002 mg./kg.; second record, 0.003 mg./kg.; third record, 0.004 mg./kg.; lower record, 0.01 mg./kg. Pressure in mm. Hg. Time—2.5 mm./sec.

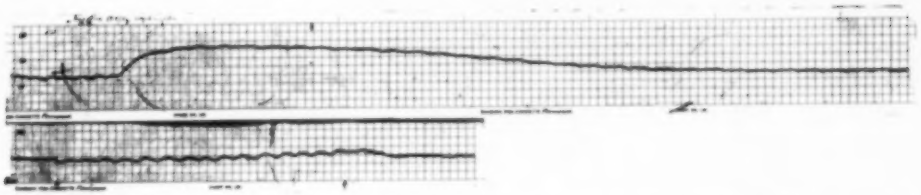

Fig. 4 (Lincoff, et al.). Effect of anoxia on intraocular pressure in cats. Upper record—response of intraocular pressure to 0.05 mg./kg. dose of succinylcholine chloride. Lower record—response of intraocular pressure to a 70-second total tracheal occlusion. Pressure—mm. Hg. Time—2.5 mm./sec.

er observed that the eyes in their subjects rotated into a divergent position upon the injection of succinylcholine, coincident with the rise in intraocular pressure. Similar rotations were observed in the eyes of the present series of cats. However, there was some doubt that this was an active rotation, caused by contraction of the eye muscles, and thus causal in the elevation of intraocular pressure.

The primary action of succinylcholine on the skeletal muscles of mammals is known to be relaxation; so it seemed possible that the eye muscles might in fact, be in flaccid paralysis, the rotation passive, and the cause of the rise in intraocular pressure due to still unsuspected factors. The following tests were therefore carried out:

In an anesthetized cat, a standard succinylcholine response was first produced; the rotation of the eye was noted to be up and out. The superior rectus was cut, and a similar dose of the drug then caused the eye to rotate inferiorly. Next the inferior oblique was isolated, a suture passed beneath its belly and the muscle drawn somewhat out of the orbit, its origin and insertion remaining intact. An injection of succinylcholine caused this muscle to pull back into the orbit.

When all the muscles but the medial rectus were cut, the eye rotated medially with the administration of succinylcholine. When the medial rectus also had been cut, minimal movement of the globe and a slight rise in intraocular pressure were still observed upon further administration of the drug. It was thought that this was due to the presence of some yet unsevered posterior attachments,[15] as well as the venous pressure factor already mentioned.

The fact that the eye rotated in the direction of the unsevered muscles, and the plainly seen withdrawal of the inferior oblique, showed that the extraocular muscles shortened and suggested that this could be the primary mechanism through which intraocular pressure is raised.

Observations on Patients

Most of the work at New York University-Bellevue Medical Center was done on patients receiving succinylcholine as a relaxant during electroshock therapy. It was thought that these data would be particularly valuable because the patients were under minimum anesthesia, similar to that desirable in eye surgery.

Patients under light anesthesia. Seventy-five electroshock patients received an average intravenous dose of 2.5 mg./kg. of sodium pentothal in combination with 0.3 mg./kg. of succinylcholine, 45 seconds before the administration of electroshock. The dose of succinylcholine given was that which would produce sufficient skeletal muscle paralysis to reduce muscular contractions to a minimum during the electroconvulsion. Within 20 to 30 seconds after administration of the relaxant drug, muscle fasciculations were frequently noticed, beginning in the face and extending over the body. These subsided in a few seconds and flaccid paralysis of the musculature took place.

TABLE 1

OBSERVED INTRAOCULAR PRESSURE (SCHIØTZ) ON LIGHTLY ANESTHETIZED PATIENTS
(all readings are in mm. Hg)

Patient Number	Initial Tension Ti	Tension after Succinylcholine Ts	Tension after ETC Tect	Ts-Ti	Tect-Ti	Patient Number	Initial Tension Ti	Tension of the Succinylcholine Ts	Tension after Tect ECT	Ts-Ti	Tect-Ti	Patient Number	Initial Tension	Tension after Succinylcholine	Tension after ECT	Ts-Ti	Tect-Ti
1	19	19	37	0	18	31	20	40	53	20	33	61	14	30	30	16	16
2	19	19	37	0	18	32	20	40	—	20	—	62	18	23	26	5	8
3	26	49	61	23	35	33	17	19	—	2	—	63	20	23	—	3	—
4	30	61	61	31	31	34	20	20	—	0	—	64	21	26	30	5	9
5	17	55	62	38	45	35	20	26	40	6	20	65	10	14	19	4	9
6	19	42	72	23	53	36	20	30	34	10	14	66	21	30	—	9	—
7	37	37	48	0	11	37	23	30	35	7	12	67	14	23	23	9	9
8	37	42	55	5	18	38	14	20	20	6	6	68	18	23	53	5	25
9	17	17	23	0	6	39	17	27	17	10	0	69	20	30	40	10	20
10	20	20	23	0	3	40	17	27	46	10	29	70	14	23	—	9	—
11	14	19	53	5	39	41	20	27	—	7	—	71	17	19	40	2	23
12	14	26	53	12	39	42	23	23	30	0	7	72	26	30	46	4	20
13	17	17	61	0	44	43	19	23	26	4	7	73	30	40	40	10	10
14	23	23	61	0	38	44	14	19	—	5	—						
15	19	19	40	0	21	45	14	23	—	9	—						
16	12	14	30	2	18	46	14	23	—	9	—	Mean Ti = 18.4 ± 5.27					
17	20	23	30	3	10	47	14	23	—	9	—						
18	11	14	27	3	16	48	19	23	—	4	—	Ts = 26.3 ± 8.29					
19	14	20	43	6	29	49	20	26	—	6	—						
20	14	32	37	18	23	50	17	20	30	3	13	Tect = 38.1 ± 12.31					
21	6	27	29	21	23	51	14	23	—	9	—						
22	12	23	—	11	—	52	15	23	20	8	5	Ts-Ti = 7.9					
23	16	27	43	11	27	53	23	34	—	11	—						
24	12	27	27	15	15	54	18	23	40	5	22	Tect-Ti = 19.0					
25	10	20	20	10	10	55	20	23	26	3	6						
26	8	27	37	19	29	56	18	23	30	5	12						
27	35	40	40	5	5	57	19	26	53	7	24						
28	21	26	26	5	5	58	16	16	26	0	10						
29	20	30	53	10	33	59	17	21	26	4	9						
30	20	30	—	10	—	60	20	20	46	0	26						

Hofmann and Holzer's conscious volunteers reported crossed diplopia and a feeling of pressure in the sockets as among the earliest subjective effects of succinylcholine. External rotation was observed in many of the patients in the present series and, in addition, enophthalmos was frequently seen. Measurements were made with a Luedde exophthalmometer, it being the one most amenable to the rapid maneuvers necessary at the shock table. Maximum retraction of as much as three mm. was recorded. While enophthalmos was the usual observation, some patients showed no alteration, and a few, exophthalmos, following succinylcholine.

At the point at which flaccid paralysis occurred, intraocular pressure was recorded with a Schiøtz tonometer. As can be seen in Table 1, the ocular tension rose in nearly all instances. The average rise was 7.9 mm. Hg; the maximum rise observed was 38 mm. Hg. Eleven patients showed a rise of more than 15 mm. Hg. Twelve patients showed no rise, but it is felt that these patients were tested so soon after administering the drug that the tonometer reading was probably taken during the latent phase, and that, if it had been possible to take another tension a few seconds later, a rise would have been recorded. It was not possible to do this, because of the necessity of proceeding with the electroshock treatment.

Most of the patients showed rises of about 5.0 mm. Hg or 10 mm. Hg as can be seen in Figure 5. The fact that the frequency

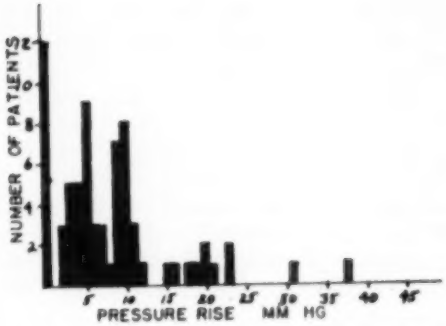

Fig. 5 (Lincoff, et al.). Frequency distribution of the responses of intraocular pressure to succinylcholine in patients receiving the relaxant drug prior to electroshock therapy.

distribution shows two distinct peaks, in addition to the group of cases showing no rise, probably indicates that the variation is at least partly due to the variable times at which observations were made. Since the observed tension depends upon the point in time on the rapidly rising pressure curve at which the recording was made, it is doubtful that there is as much variation in the pressure rise among patients as the records indicate. It is likely that 7.8 mm. Hg represents average pressure, taken at the middle of the curve, and twice that, namely 15.6 mm. Hg, the mean maximum rise. It is of interest that in experiments in cats, during which continuous recording of intraocular pressure was possible, the usual maximum pressure rise was about 15 mm. Hg.

Influence of electroshock. It is not the purpose of this paper to enter into a discussion of the effects of electroshock on intraocular pressure for which reference should be made to several recent papers.[16–18] The heretofore mentioned rises due to succinylcholine were measured in all instances before the shock was administered. However, measurements were also made on patients after the electroconvulsive treatment. These readings were, of course, influenced by the electroshock, which in itself raises intraocular pressure precipitously. Arstikaitis and Hodgson[18] noted that electroshock raises intraocular pressure 2.0 to 16 mm. Hg. In our series, postshock tension, recorded as soon as possible after the cessation of the shock (generally within 30 seconds), on patients who had received succinylcholine, was considerably higher than that usually recorded after shock alone.

Among those patients who received succinylcholine prior to shock, the *average* postshock rise was 19 mm. Hg. Ten patients showed a rise of more than 30 mm. Hg. One patient's tension had risen 53 mm. Hg in the left eye and 45 mm. Hg in the right.

Serial tensions taken after the shock showed a brief maintenance of a maximum plateau, followed by a gradual return to initial or subinitial tension within five minutes. In no instance did the tension fail to return to normal in five minutes.

Glaucoma. Two patients with chronic wide-angle glaucoma who were given succinylcholine in connection with electroshock therapy were observed. In both cases the tension rose less than the average both before and after the electroshock and returned to the initial level within five minutes. The observations made on these two patients alone are not, of course, sufficient to determine the advisability or nonadvisability of using succinylcholine in cases of glaucoma; however, if one accepts the hypothesis that the rise in pressure following succinylcholine is caused by contraction of the extraocular muscles, its action on a glaucomatous eye would be no more than that of a brief massage, and would not be harmful. At present it is felt that the use of succinylcholine is probably not contraindicated in general surgical or shock patients who have wide-angle glaucoma.

Patients under deeper anesthesia

General surgical patients. The next series of observations was made on 10 general surgical patients under inhalation anesthesia. These patients had all been given routine premedication of atropine (0.4 mg.) and Demerol (100 mg.). They were under

nitrous oxide, cyclopropane, or a combination of cyclopropane and ether. They were in Stage III, plane 1 or 2 anesthesia.

Even when given repeated doses of succinylcholine as high as 60 mg., none of these patients showed a significant change in ocular tension. Fasciculations over the face and body were frequently noticed after these injections, and in every case relaxation of the skeletal musculature was confirmed. It was apparent that, even at these levels of anesthesia, the expected relaxant effect of succinylcholine was taking place. Why the intraocular pressure response, which was regularly observed in the shock patients who were under light pentothal anesthesia, did not occur in the general surgical patients, remains unexplained. It is possible that surgical anesthesia reduces to a minimum the response of the ocular muscles, and thus minimizes their action on the intraocular pressure, in response to succinylcholine.

Eye surgery patients. Finally, three patients who required enucleation for intraorbital tumors were observed under pentothal anesthesia. An attempt was made to reproduce Hofmann and Holzer's experiment in two similar cases.

In the first of our cases, a 66-kg. patient was induced with pentothal and cyclopropane, and subsequently carried very lightly on pentothal, nitrous oxide and oxygen.

Soon after anesthesia was induced, but before the surgical procedure was started, the patient showed a rise in intraocular pressure of 11 mm. Hg on being given 15 mg. of succinylcholine. Definite rotation and enophthalmos of the globe were observed. After all the straight muscles except the medial rectus were severed, the injection of 15 mg. of succinylcholine was followed by medial rotation of the globe, and the ocular tension rose 6.0 mm. Hg. The unoperated eye showed a pressure rise of 10 mm. Hg. Second and third injections of 15 and 20 mg. respectively, after suitable recovery times, also produced rises of 6.0 mm. Hg, with medial rotation. Finally, after the medial rectus was cut, there were rises of 2.0 and 4.0 mm. Hg after two injections of 20 mg. of succinylcholine.

It will be recalled that small rises in pressure were recorded in cats when succinylcholine was injected after all the eye muscles had been cut. It is felt that the rises in intraocular pressure recorded at this stage in the human subject were similarly due, either to intercurrent factors outside the orbit or, possibly, to yet unsevered fibers of the obliques.

The other two patients who underwent enucleation showed only minor rises in tension prior to sectioning of the muscles but, after sectioning of the muscles, the rises seen were even smaller. It was felt that their ocular tensions were relatively immune to the succinylcholine because of the depth of anesthesia.

None of these three patients showed the consistent rise in tension that Hofmann and Holzer recorded in their enucleation cases. This may be attributable to the use of inhalation anesthesia in conjunction with the pentothal drip, in the present cases; whereas, Hofmann and Holzer used only pentothal and oxygen. Nevertheless, it was felt that although in two of the three cases the effects were slight, observations on the enucleation patients parallel the observations made on cats, and support the hypothesis that an active shortening of the extraocular muscles causes the rise in tension seen after administration of succinylcholine.

Final experiment

During the work just described, it was noted that, following rapid injection of succinylcholine, fasciculations in many cases were visible initially in the muscles of the face and body. The presence of these twitchings suggested that perhaps the eye muscles, too, may fasciculate initially upon depolarization. It was felt that these contractions might be the cause of the increase in intraocular pressure. This gave rise to the hope that, if the initial twitching could be elimi-

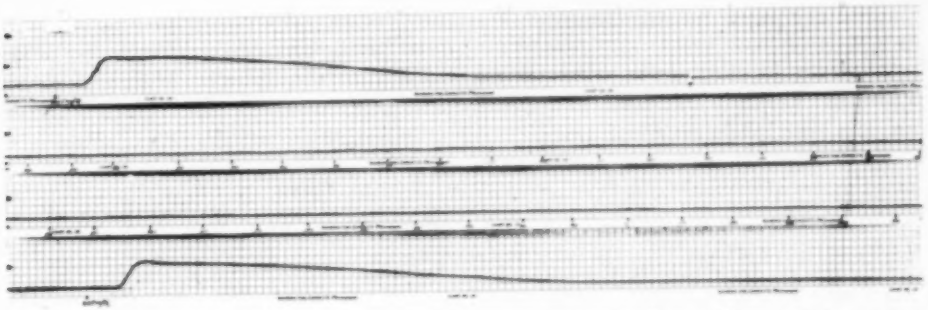

Fig. 6 (Lincoff, et al.). Effect of succinylcholine on intraocular pressure in cats. Upper record—response to 0.05 mg./kg. dose. Middle record—repeated injections of 0.001 mg./kg. at 15 sec. intervals. Lower record—response to 0.05 mg./kg. The entire continuous record is shown. Pressure in mm. Hg. Time—2.5 mm./sec.

nated by injecting the succinylcholine very slowly, or by continuous drip, the drug might yet prove to be useful as a curare-like agent in intraocular surgery. The following experiment was undertaken to test this theory:

A cat under the usual nembutal anesthesia was given an intravenous drip of sufficient succinylcholine (0.004 mg./kg./min.) to maintain 90-percent paralysis of the skeletal musculature as measured by the gastrocnemius response. The eye pressure was noted to be unaffected. When 0.05 mg./kg. of succinylcholine was injected, however, in spite of the nearly complete block of skeletal muscle then existent in the rest of the body, the globe was seen to rotate, and the usual rise in intraocular pressure took place (fig. 6). The kick response was now totally blocked. It is thus apparent that the intravenous drip was subthreshold for the ocular muscles, which were not relaxed when the rest of the musculature was flaccid.

Two of the observations made in the previous tests on both cats and patients are also significant in this connection:

1. It will be recalled that there are only two phases to the observed rotation of the globe which accompanies the rise in intraocular pressure: rotation to a position of prolonged fixation and counter-rotation to restored mobility.

If initial fasciculations played a part in this process, one would expect the sequence to be: first, rotation to a position of fixation lasting 10 to 20 seconds (the duration of the fasciculations); secondly, counter-rotation when the muscles become flaccid; and finally, a third rotation when mobility is restored. This sequence does not occur.

2. The observation that minimum doses cause minimum rises in pressure, and the close quantitative relationship that exists between dose, rotation and pressure rise, indicated that if sufficient succinylcholine is used to fix the globe regardless of the rate of administration a sizable rise in pressure will always occur.

It is evident that the response of the ocular muscles to succinylcholine differs from that of the other skeletal muscles. The threshold of response of the ocular muscles is higher, and their reaction is one of sustained contracture, as opposed to relaxation. Eye muscles are a peculiar histologic and philogenetic structure. It is interesting to note that they are not the only animal muscles to respond in this way to depolarizing relaxants; both bird muscle and frog belly muscles are also known to contract when succinylcholine is injected.

Conclusions

1. Succinylcholine causes intraocular pressure to rise and should be used in intraocular

surgery only with full cognizance of this fact.

2. Maximum rises are seen in patients under light pentothal anesthesia. Lesser rises are seen with inhalation anesthesia.

3. The rise in intraocular pressure is probably secondary to contraction (contracture) of the extraocular muscles.

4. Succinylcholine is probably not contraindicated in patients who have deep-chamber glaucoma and who must undergo general surgery or electroshock.

2 Fifth Avenue.

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THE PRISCOLINE PROVOCATIVE TEST*

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In 1954 Leydhecker[1] reported the use of subconjunctival Priscoline (2 benzyl imidazoline hydrochloride) as a provocative test for primary chronic glaucoma. He found it to be positive approximately twice as often as was the water test in eyes with known primary glaucoma but was not as often positive as with Vasculat.[2] A study was undertaken in the Glaucoma Clinic, Detroit Receiving Hospital, to evaluate this test.

The Priscoline test is done as follows:

After tonometry, a cotton-wool applicator dipped in one-percent pontocaine is placed against the bulbar conjunctiva in the 12-o'clock position while the patient looks down and the upper lid is retracted. After 30 to 60 seconds, 1.0 cc. Priscoline (10 mg. in one cc. water) is injected under the upper conjunctiva. Tonometry is repeated after 15, 30, 60, and 90 minutes. The tension begins to rise a few minutes after injection, often reaching a maximum in 15 minutes. Leydhecker considered a rise of 11 to 13 mm. Hg (Schiøtz) to be a probable pathologic test, and a rise of 14 mm. or more a definite pathologic result. These values were determined by Leydhecker from a study of 62 normal eyes in which he found an average rise of 4.9 mm. Hg (Schiøtz), and a maximum rise to a ceiling of 39.8 mm. Hg.

Priscoline test in normal eyes

In 18 normal eyes (table 1) with initial tension of 17.1 to 26.5 mm. Hg (Schiøtz,

* From the Glaucoma Clinic, Detroit Receiving Hospital.

TABLE 1

RESULTS OF PRISCOLINE TEST IN NORMAL EYES

Eye No.	Control 30 min. before initial (mm. Hg tension)	Initial Tension (mm. Hg)	Tension after Injection (in mm. Hg [Schiotz])				Increase Tension in (mm. Hg)	Time of Maximum Increase (min.)	Age (yr.)	Sex
			15 min.	30 min.	60 min.	90 min.				
1	19.9	19.9	19.9	19.9	19.9		0.0		41	F
2	21.5	21.5	23.0	26.5	23.0		5.0	30	41	F
3		17.3	24.0	24.0	19.0	18.0	6.7	15	50	F
4		17.3	24.0	24.0	17.3	17.3	6.7	15	50	F
5		17.1	19.9	23.0	23.0	24.6	7.5	90	48	F
6		19.0	21.5	26.5	24.6	24.6	5.6	30	48	F
7		26.5	26.5	26.5	26.5	26.5	0.0		54	F
8		26.5	30.3	30.3	30.3	26.5	3.8	15	54	F
9	18.5	18.5	24.6	24.6	19.9		5.9	15	54	M
10	21.5	21.5	26.5	23.0	23.0		5.0	15	54	M
11		17.1	15.7	17.1	19.9		2.8	60	73	M
12	17.1	19.9	18.5	18.5	19.9		0.0		73	M
13		19.0	27.0	22.0	23.0	22.0	8.0	15	42	F
14		22.0	27.0	27.0	30.0	26.0	8.0	60	42	F
15		19.9	23.0	23.0	23.0	26.0	6.4	90	74	M
16		21.5	24.6	26.5	24.6	26.0	5.0	30	74	M
17		19.0	21.5	26.5	23.0		7.0	30	64	F
18		21.5	27.0	26.5	22.0		5.5	15	64	F

1948 scale), the use of the Priscoline caused an average rise of tension of 4.8 mm. Hg, which compares closely with Leydhecker's average of 4.9 mm. Hg. The maximum increase was 8.0 mm. Hg; the maximum tension 30.3 mm. Hg. This indicates some variance from Leydhecker's criteria of the probable and definitely pathologic. Our criteria on the basis of this admittedly small series of normal eyes would be a rise of 9.0 mm. Hg or more, or a rise from normal to 32 mm. Hg instead of the 11-mm. Hg rise of Leydhecker.

The time required for the maximum rise in tension was, in agreement with Leydhecker, most frequently 15 minutes. Of 15 eyes which showed a tension rise during the test, the 15-minute reading was highest in seven, the 30-minute reading in four, and the 60- and 90-minute readings in two each.

Studies of the visual fields, fundi, and tension were negative in each of the control eyes.

PRISCOLINE TEST IN UNOPERATED SIMPLE GLAUCOMA

A total of 30 eyes in 18 patients with known simple (open-angle) glaucoma were studied. The results are shown in Table 2. An average rise of 8.5 mm. Hg was found.

Using Leydhecker's criteria, only eight of 30 eyes (26.6 percent) would be considered positive. This would compare unfavorably with the 12 positive water tests in this series. (The criteria for a positive water test were a tension rise of over 9.0 mm. Hg or to over 32 mm. Hg.)

Using our own criterion for a positive Priscoline test as a rise of 9.0 mm. Hg or more, 14 eyes (46.6 percent) responded positively. Under these conditions the test results would be somewhat better than with the water test.

The period of maximal rise of tension during the test was at 15 minutes in 10 eyes, 30 minutes in 11 eyes, 60 minutes in five, and 80 minutes in three eyes.

In comparing the positive Priscoline with the water test the Priscoline was negative while the water test was positive in six instances. In four eyes the Priscoline test was positive while the water test was negative.

Tonographic studies in 19 eyes of this same series showed six low coefficients of outflow, equivocal ones (0.15) in two eyes,

TABLE 2

PRISCOLINE TESTS IN UNOPERATED CHRONIC SIMPLE GLAUCOMA

Eye No.	Tension in mm. Hg. Schiotz						Tension Rise (mm. Hg)	Priscoline Test Criteria		H_2O Test	Tonography C =
	Control 30 min. Before Test	Initial	15 min.	30 min.	60 min.	90 min.		Sugar, Santos	Leydhecker		
		After Priscoline Injection									
1	24.6	28.5	30.3	37.2	37.2		8.9	—	—	+	0.025
2	26.3	30.3	37.2	40.0	34.7		9.7	+	—	—	0.03
3		30.3	37.2	37.2			6.9	—	—	+	
4		32.3	37.2	37.2			4.9	—	—	+	
5	23.0	23.0	30.3	34.7	34.7		11.7	+	+	+	0.05
6	24.6	24.6	30.3	37.2	34.7		13.4	+	+	—	0.07
7	26.5	30.3	28.3	28.3	30.3	28.3	0.0	—	—	—	0.09
8	24.6	28.3	30.3	28.3	28.3	28.3	0.0	—	—	—	0.09
9	19.9	23.0	28.3	30.3	30.3	28.3	7.3	—	—	—	
10	24.6	26.5	28.3	24.6	28.3	28.3	2.0	—	—	+	
11		19.0	30.3	34.7	30.3		15.7	+	+	+	
12		23.0	34.7	34.7	42.5		19.5	+	+	+	
13	30.3	30.3	37.4	40.0	30.3		9.7	+	—		0.02
14	28.3	28.3	28.3	34.7	30.3	26.5	6.4	—	—	+	0.22
15	28.3	28.3	30.3	30.3	28.3	26.5	1.7	—	—	+	0.15
16	32.5	30.3	40.0	40.0	40.0	42.7	9.7	+	—		0.10
17	24.6	26.5	30.3	30.3	34.7	37.2	8.2	—	—		0.07
18	23.0	23.0	30.3	26.5	26.5		7.3	—	—	—	
19	21.5	23.0	30.3	26.5	26.5		7.3	—	—	—	
20	34.7	34.7	34.7	37.2	37.2		3.5	—	—		
21	24.6	26.5	30.3	30.3	32.3		4.0	—	—		0.11
22	18.5	19.9	28.3	30.3	37.2	30.2	17.2	+	+	—	0.08
23	18.5	18.4	24.6	28.3	30.3	30.3	12.0	+	+	—	0.08
24	19.9	19.9	26.5	34.7	32.3		14.8	+	+	+	0.07
25	30.3	34.7	34.7	34.7	34.7	46.0	11.3	+	+	+	0.04
26	26.5	24.6	34.7	32.3			10.0	+	—	+	0.02
27	17.1	21.5	24.6	26.5	28.3	26.5	7.8	—	—		0.15
28	18.5	19.9	24.6	30.3	28.3	23.0	9.8	+	—		0.01
29	25.4	26.5	37.2	32.3	32.3		9.7	+	—		
30	29.5	30.0	34.7	32.3	32.3		4.7	—	—		

and a definitely normal value in one eye (0.22).

A study of the relation between the initial pressure and the amount of rise of pressure (table 3) showed that the highest increases in pressure tended to occur in eyes with the lowest initial pressure but not characteristically so.

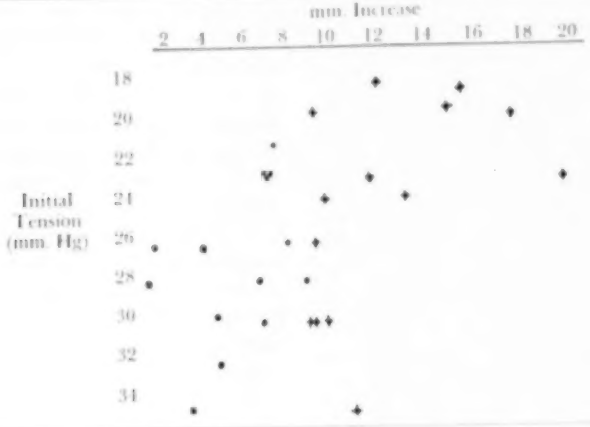
Leydhecker[2, 4] found the water test to be positive in 32.9 percent of known simple glaucomatous eyes. Kronfeld[3] found positive results in 45.5 percent and Sugar[5] in 44 percent. Compared to these values, Leydhecker found the Priscoline test to be positive in 55 percent of glaucomatous eyes. Kronfeld, using the same criterion of a rise of 11 mm. Hg or more, found the test positive in 54 percent. Our findings with the same criteria would be 26.6 percent, and with our criteria 46.6 percent. We believe that further studies are indicated to determine more closely the value of the Priscoline test in the diagnosis of simple glaucoma.

PRISCOLINE TEST IN OPERATED SIMPLE GLAUCOMA

The Priscoline test was performed in six eyes of five patients with advanced simple glaucoma which had been successfully operated upon. The results are shown in Table 4. An average rise of 3.3 mm. Hg was found. The highest rise was 6.0 mm. in the one eye with a bleb which had the appearance of questionable filtration. All tests were negative. The filtering blebs certainly were able to accommodate any possible increase in

TABLE 3

RELATION BETWEEN INITIAL TENSION AND AMOUNT OF INCREASE FOLLOWING PRISCOLINE TEST



• = negative
+ = positive test.

aqueous volume which may have been produced. These eyes showed less average tension increase than did the normal eyes.

COMPLICATIONS

Leydhecker's preference for Priscoline over Vasculat was due to its relative painlessness on the day of injection. He reported that edema and redness do not usually persist after the first day and that procaine is unnecessary. In all of our patients injection of the Priscoline subconjunctivally after surface anesthesia was usually without discomfort. One patient complained of a burning sensation for 16 hours and one complained of headache (blood pressure normal). Several patients developed small subconjunctival hemorrhages. A total one-cc. injection could not be accomplished in each eye of the same patients in two instances. In one patient only 0.5 cc. of injected fluid was tolerated. In the second patient 0.75 cc. was tolerated on each eye. Five patients complained of extreme soreness of the eyes that day. In one instance the eye remained markedly injected for four days.

A more serious possible complication occurred in one patient who was well controlled

TABLE 4

RESULTS OF THE PRISCOLINE TEST IN SUCCESSFULLY OPERATED SIMPLE GLAUCOMA

Eye No.	Operative Procedure	Appearance of Bleb	Tension Range during Previous Year (mm. Hg)	Initial Tension	Tension in mm. Hg. Schiøtz after Priscoline Injection				Tension Rise (mm. Hg)
					15 min.	30 min.	60 min.	90 min.	
1	Trephining	Functioning	17–20	9.7	11.5	9.7	10.6	10.6	1.8
2	Trephining	Functioning	20–26	20.0	21.8	21.8	21.8	18.7	1.8
3	Iridencleisis	Functioning	10–26	17.5	17.5	18.7	20.7	18.7	3.2
4	Iridencleisis	Functioning	21–24	23.5	27.4	27.4	27.4	23.5	3.9
5	Iridencleisis	Questionably Functioning	20–25	23.5	23.5	28.0	29.5	23.5	6.0
6	Iridencleisis	Functioning	15–20	17.0	20.2	17.0	20.2	20.2	3.6

previous to the time of the Priscoline test but showed a subsequent failure of control which required surgery. This, of course, may be coincidental, but it may represent a bona fide complication. This patient, a 67-year-old woman with a blood pressure of 170/110 mm. Hg, had an ocular tension, partially controlled by pilocarpine and eserine, which varied between 24 and 37 mm. Hg. (Schiøtz) for two months. Tonography showed a coefficient of outflow of 0.25 (R.E.) and 0.03 (L.E.). The peripheral visual fields were reduced concentrically by 20 degrees. The initial tensions before the Priscoline test were: R.E., 24.5 mm. Hg; L.E., 26.5 mm. Hg. The Priscoline caused a rise of 8.9 mm. Hg. in the right eye (eye number 1 in table 2) and 9.7 mm. Hg in the other eye (eye number 2, table 2). One month later the tension was 42 mm. Hg (Schiøtz) in each eye in spite of pilocarpine. On January 4th, it was 55 mm. Hg in each eye. The patient was then hospitalized for surgery.

The effect on the pupil was noted following the injection of the Priscoline in all of these cases. In five eyes there was a localized drawing up of the pupil toward the site of injection, such as occurs where epinephrine has been injected subconjunctivally at a single site.

The mechanism of the Priscoline test has only been speculated upon. Kronfeld[3] found that tonography at the time of the tension rise revealed no significant change in the facility of outflow. He suggested that the test may, therefore, be based on an increase in the rate of aqueous formation.

Conclusions

A study of the Priscoline test on a small number of normal eyes revealed an average rise of 4.9 mm. Hg (Schiøtz), a maximum rise of 8.0 mm. Hg and a maximum tension of 30.3 mm. Hg. This leads us to consider Leydhecker's criteria of a positive Priscoline test as too high. At least, it indicates that further evaluation of the criteria in this test is needed.

A study of the results of the Priscoline test in 30 unoperated eyes with known simple glaucoma showed it to be positive in 46.6 percent of these eyes when our criteria were used and in only 26.6 percent when Leydhecker's criteria were used.

In six successfully operated eyes with simple glaucoma, the test was negative in all cases. The low average increase in tension of 3.3 mm. Hg indicates that the filtering blebs enable the operated eyes to handle a possible increase in aqueous volume even better than normal eyes.

Certain possible complications of the test are described. It is not a test which can comfortably be given to patients in office practice. It is suggested that it may be useful in cases in which the water test cannot be tolerated. It is our opinion that the water test, with all its drawbacks, remains the most convenient provocative test.

28 West Adams (26).

We wish to express our appreciation to Dr. J. Garth Chatterly who assisted in the work in performing the tests on the successfully operated glaucomatous eyes.

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CONCERNING THE PATHOGENESIS OF RETINAL HOLES*

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Our concept of the role which the vitreous body plays in the pathogenesis of some retinal defects has been modified in recent years by information gained from biomicroscopy of the posterior segment.

The importance of the vitreous in the formation of retinal tears has been recognized almost from the beginning of our realization of their essential role in the development of the idiopathic retinal separation. Little has been added to Gonin's[1] original concept of the relationship between vitreoretinal adhesions and the flap or "horse-shoe" tears.

The pathogenesis of retinal holes, on the other hand, is more complex and varied, especially regarding the associated pathologic vitreous patterns. It is relative to these, that biomicroscopy has added so much to our understanding (Lindner,[2] Hruby,[3] Boeck,[4] Fuchs,[5] and others). I shall not attempt a survey or discussion of the pertinent literature but shall confine myself to the demonstration of some clinical and histologic features in the three following cases, which tend to illuminate these newer concepts.

CASE REPORTS

CASE 1

This specimen is the left eye, obtained postmortem, of F. M. R., a man 72 years of age. Five years prior to the patient's death a preliminary total iridectomy was performed on the left eye, and a month later an extracapsular lens extraction was done during which a slight amount of vitreous was lost. The final visual acuity was 1.0. A year and a half after the cataract extraction a retinal separation developed in the nasal half, which was operated successfully with diathermy punctures, restoring the original vision of 1.0. No mention was made in the history of retinal tears or holes. Two years later a retinal detachment occurred in the temporal half of this eye. Two surgical procedures consisting of diathermy punctures, performed a month apart, resulted in complete reattachment of the retina with a vision of 0.4. At that time a macular lesion thought to be an incipient hole was noted.

Within the following two years a definite macular hole developed, and closure of the hole by direct application of diathermy to the macular region was attempted.

The patient died of coronary occlusion during the convalescent period after this last procedure.

On the patient's right eye an intracapsular lens extraction had been performed two years prior to the first operation on the left eye, with an initial visual result of 1.0. A retinal separation, which developed three months afterward, was unsuccessfully operated, and the vision of the right eye was finally lost by a total retinal separation and secondary glaucoma.

Histologic findings

The left eye was fixed in formalin, embedded in celloidin, and sectioned serially in a vertical direction.

At the upper limbus there was a well-healed penetrating (postoperative) scar. The cornea was normal, the anterior chamber was deep, and the chamber angle open everywhere with unusually thick and pigmented iris spurs reflecting over the inner surface of the trabecula and the posterior surface of the cornea.

The area of the total iris coloboma was partly filled with posterior lens capsule, some cortical remnants, and prolapsed vitreous. There was incarceration of vitreous into the internal portion of the postoperative scar at one place. The remainder of the iris was

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normal. Part of a Soemmerring ring was lying behind the iris inferiorly.

The angle of the anterior chamber and the ciliary muscle had a myopic configuration. The inferior temporal and superior equatorial regions of the sclera were studded with narrow diathermic micropunctures and the choroid and retina in the corresponding areas were extensively necrotic. The retina was artificially detached in some places, but there was no evidence of an intravitam retinal separation. Thin fibrous or glial membranes covered extensive areas of the inner retinal surface (Leber's preretinitis), especially at the posterior polar region, where they had caused an accordionlike pleating of the innermost layers of the retina and a hole in the macula (figs. 5 and 6).

The vitreous was extensively detached and was lying almost entirely within the anterior half of the cavum oculi. Several strands of vitreous were adherent to the retina in the superior postoperative field. At one place a hole in the "in situ" retina had formed a short distance behind one of these vitreoretinal adhesions. Serial sections through the retina adjacent to this hole on each side demonstrated well the traction exerted by the adhesion upon the retina, which showed some cystic degeneration and thinning. It was at the site of one of these cysts some distance away from the adhesion and not at the actual site of the adhesion that the retina broke (fig. 2).

At the anterior margin of the hole a splitting of the retina was a further result of the pull exerted upon it by the vitreoretinal adhesion. This adhesion was fortified by elongated, flat cells which had grown from the inner surface of the retina onto its sides (fig. 2). The postoperative chorioretinal adhesion extended a short distance proximally beyond the hole.

The optic nerve was normal.

Discussion

1. In this case, an unusually firm adhesion between vitreous and the postoperative scar had produced a hole in the "in situ" retina. Such firm vitreal adhesions to the postoperative scar have been observed clinically by many (Lindner,[3] Boeck,[4] and others) and the question has been raised whether they could be responsible for recurrences of the retinal detachment.

In our case the postoperative chorioretinitic adhesion extended well beyond the area of the hole. It seems unlikely that this particular hole would have led to a new retinal separation.

A strong vitreal adhesion near the proximal edge of the operative field might, however, lead to a hole in the adjacent, surgically untouched retina and thus to a fresh detachment, especially if this portion of the retina is not entirely normal. Only careful postoperative examinations with the biomicroscope will show in the future how often this really happens.

2. A sequence of sections through the hole, the vitreal adhesion, and the adjacent area (figs. 1 to 4), showing the topographic relations of these structures to each other in our case, appears to illustrate the chronologic sequence of events as well, from the pull upon the retina exerted by the band of vitreous, to the increasing dehiscence in the retina at a locus minoris resistentiae some distance from the vitreoretinal adhesion, to the actual hole formation at this site, and a subsequent splitting of the adjacent retina.

3. The vitreoretinal adhesion at the site of the postoperative scar was made especially firm in this case by a thin layer of cells, which had grown from the inner surface of the retina onto the sides of the vitreal strand. This cellular growth, fortifying the adhesion, was possibly part of the widespread, postoperative tissue reaction. Yet, the hole had not formed at the place of greatest traction but at the site of the most pronounced degeneration and thinning of the retina in a region not even in contact with the vitreous.

4. Continued traction by the vitreal adhesion had also caused a splitting, namely, a

Fig. 1 (Klien). *Case 1.* Vitreoretinal adhesion in postoperative field. (S) Splitting of retina. (C) Group of cysts in degenerated retina.

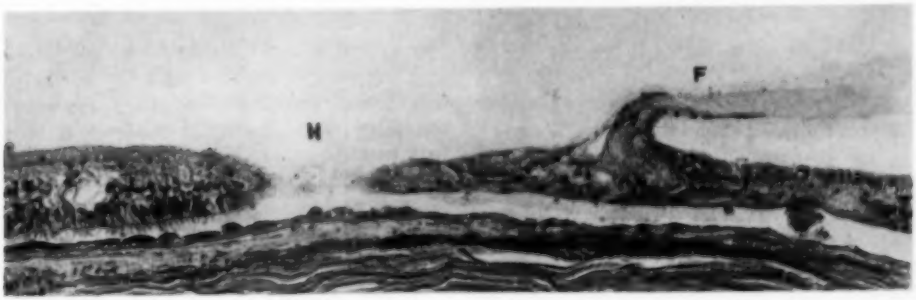

Fig. 2 (Klien). *Case 1.* Eight sections away from area shown in Figure 1. (F) Vitreoretinal adhesion fortified by growth of cells over it. (H) Hole in retina some distance away from adhesion, corresponding approximately to distance of largest cyst from adhesion, as shown in Figure 1.

Fig. 3 (Klien). *Case 1.* Eleven sections away from area shown in Figure 2. Widest diameter of retinal hole. There is no retinal detachment. Necrotic debris has replaced neuroepithelium distally from hole. Neuroepithelium preserved almost to rounded proximal edge of hole.

partial tear of the retina, at the margin of the hole.

CASE 2

A. B., a man 54 years of age, had noted blurring of his right vision five weeks prior to the time when the illustration shown in Figure 5 was made. A focus of acute chorioiditis in the lower periphery of the right eye, with marked exudation into the vitreous, was found by the ophthalmologist whom he consulted at that time.

The vitreous gradually cleared and the vision improved considerably until the end

Fig. 4 (Klien). *Case 1.* Eight sections away from area shown in Figure 3. (The other side of the hole.) There is again a cyst some distance away from vitreoretinal adhesion, and splitting of the retina at site of adhesion by traction from it.

of the fourth week, when the retina became detached.

At that time the corrected vision in the right eye was 0.4. The left eye was normal.

The vitreous of the right eye contained many white ovoid opacities in the lower periphery, but was only slightly and diffusely hazy elsewhere.

The retinal separation attained a height of eight to nine diopters in the temporal periphery but flattened toward the macular region and the superior and inferior periphery. In the temporal equatorial region on the horizontal meridian there was a retinal hole with an operculum floating a short distance in front of it, and casting a shadow upon the underlying retina. This perfectly round operculum was attached by a narrow thread of gray tissue to one side of a rent-like prolongation of the round retinal defect.

The vitreous, as seen with the biomicroscope, was extensively detached above but not within the region of the retinal hole. Bands of greater density appeared to criss-cross it throughout, and one of these condensations was attached to the operculum.

Comment

Holes, forming in relation to vitreal adhesions, may arise:

1. At a locus minoris resistentiae some distance away from the adhesion but by traction from it.

2. At the actual site of the adhesion, when a round operculum is torn out and often remains floating in front of the hole, as illustrated in Case 2.

These holes may be combined with rents

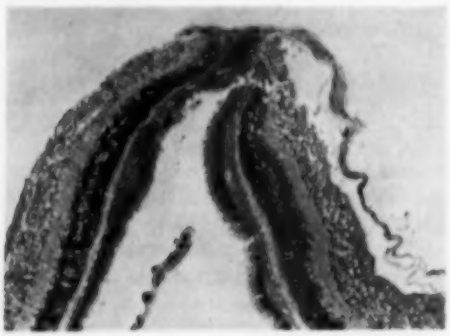

Fig. 5 (Klien). *Case 1.* Macular area with fibrous membrane on inner surface of retina. No vitreous adhesions.

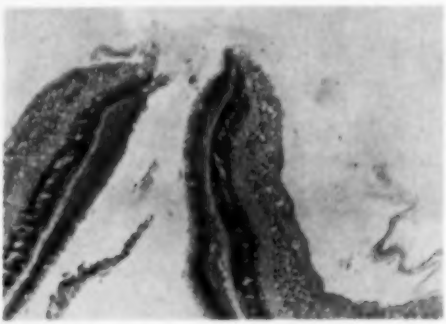

Fig. 6 (Klien). *Case 1.* Eleven sections away from area shown in Figure 5. Hole in fovea centralis.

or tears as is suggested by the histologic findings in Case 1, where a partial tear was added to the hole, apparently at a later date, and by the clinical findings in Case 2.

The shape of the retinal defect in Case 2 suggested a combination of hole and tear, which need not have formed at the same time. An unusually strong and broad attachment of the vitreous to the inner surface of the retina, in this case probably fortified by residua of the inflammatory process, prevented the complete severance of the operculum from the edge of the hole at one place. Continued traction by a firm and shrinking vitreous band at this very place produced the vertical rent in the retina, probably in much the same manner as the partial tear, illustrated in the histologic pictures of Case 1, was produced in addition to the hole.

Deductions of practical importance from a clinical picture, such as is illustrated in Case 2, are the existence of a fortified vitreoretinal adhesion and of a progressive shrinking process within the vitreous body.

CASE 3

W. B., a man 53 years of age, noted sudden blurring of the vision of his right eye while reading three days prior to the first examination. At that time there was a retinal detachment over the entire superior half with two small holes in the superior nasal equatorial region.

Two surgical procedures were performed consisting of rows of diathermy punctures around the region of the holes. The retinal detachment, however, progressed and became total within three months, forming large bullae. There was a group of small holes in the extreme temporal periphery. On transillumination a shadow was noted in the temporal periphery and the eye was removed on suspicion of a tumor three months after the onset of the visual disturbance. The intraocular pressure of the right eye was 16.0 mm. Hg (Schiøtz).

The left eye was normal in every respect with a corrected vision of 1.0.

Fig. 7 (Klien). *Case 2.* Hole in detached retina with rentlike prolongation. Operculum, casting a shadow, floating near hole, attached to edge of rent by thin gray strand.

Histologic findings

The eye was fixed in Mueller's solution and sectioned serially in a horizontal plane.

Cornea, anterior chamber, and iris were normal. The ciliary muscle had a myopic configuration, the lens was in situ. The superior and nasal equatorial sclera was studded with narrow perforating puncture scars. Corresponding to the site of these punctures there was extensive necrosis of the choroid, the posterior half of the orbiculus ciliaris, and the oral retina.

In the temporal equatorial region there was a massive subchoroidal hemmorhage, which extended forward to a region behind the corona ciliaris, and which had probably caused the shadow noted clinically on transillumination.

The vitreous was detached posteriorly and well forward to the equatorial region. It seemed to be rather firmly anchored to the postoperative scar by a well-defined strand which appeared dense and fortified by long, flat cells, growing from the scar into the vitreous (fig. 8). Behind this nasal vitreal adhesion the retina was extremely degen-

Fig. 8 (Klien). *Case 3.* Area of operative field. (M) Micropuncture. (F) Vitreoretinal adhesion fortified by cellular growth on posterior surface of detached vitreous. Extensive necrosis of choroid and retina. (H) Hole in retina.

erated and thin, and in one place a hole (fig. 8) had formed through which the subretinal and subvitreal coagulum were connected.

It is not certain whether this was one of the breaks noted preoperatively in the superior nasal periphery, or whether it occurred postoperatively. It was not situated within the range of traction of a vitreoretinal adhesion, but within a portion of retina shortened by neighboring preretinitis and fixed folds.

The oral retina on the side opposite the surgical field also revealed marked cystic degeneration and thinning.

The retina was completely detached and the subretinal coagulum adjacent to the area of subchoroidal hemorrhage contained a small amount of free hemorrhage.

In several places there was a thin, fibrous membrane on the inner surface of the retina. At one place near the posterior polar region shallow folds of the inner layers of the retina were drawn together toward one point and fixed in this position by the preretinal fibrous tissue (fig. 9). This formation illustrates well the folds which are clinically described as star folds (Gonin,[1] Boeck,[4] and others) or foci of retinal shrinkage (Lindner,[2] and others), and which represent an unfavorable prognostic sign.

The optic nerve appeared normal.

Discussion

1. In this apparently myopic eye holes rather than tears were found clinically in several locations, and histologically at one place.

Holes are less obvious and more difficult to demonstrate histologically than tears, especially if they arise without traction from vitreoretinal adhesions in the neighborhood of fixed folds, as in this case.

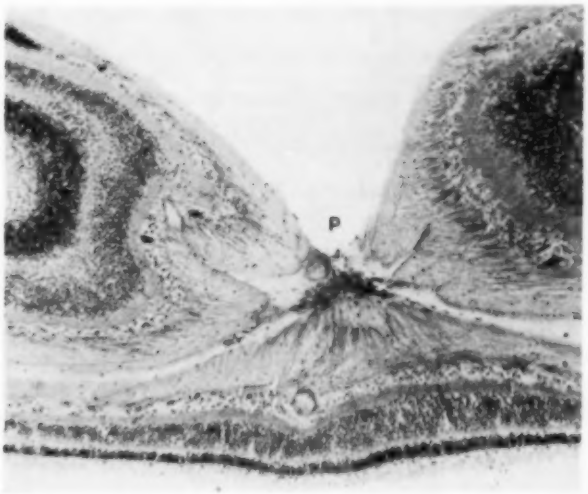

Fig. 9 (Klien) *Case 3.* Star fold, slightly tangential section. The inner layers of the retina are drawn together by small amount of fibrous tissue (P) on inner surface of retina.

2. The rapidity with which folds may become fixed, and thus unfavorably influence the surgical result, is noteworthy. Only three months after a partial retinal separation was first noted subjectively, folds fixed by thin but extensive preretinal membranes were noted histologically within the expanse of the posterior vitreous detachment. A star fold was demonstrable histologically at least in one place, suggesting one of the reasons for the poor surgical result in this case.

3. In this case as in Case 1 the vitreoretinal adhesion within the operative field was fortified by growth of cells from the retinal to the vitreal surface.

4. Shadows on transillumination after extensive surgical procedures may be due to a subretinal or subchoroidal hemorrhage rather than a tumor, especially when transillumination was negative before surgery.

Summary and Conclusions

In the foregoing, examples of three different varieties of retinal holes have been illustrated:

1. Holes, which form in relation to a vitreoretinal adhesion but not at its actual site, by traction from the adhesion upon a locus minoris resistentiae of degenerated retina some distance away.

2. Holes, which form at the actual site of vitreoretinal adhesions by the tearing out of an operculum.

Rents may be added to these two kinds of holes if a fortified vitreous band or the operculum somehow remain in contact with the margin of the hole.

3. Holes, which arise by traction from shrinking preretinal membranes in areas where contact between retina and vitreous had been lost for a long time. Such areas are the vicinity of star folds and, with predilection, the fova centralis.

Vitreoretinal adhesions may become fortified by fibrous or glial membranes representing the residua of endogenous or postoperative inflammation.

A star fold could be demonstrated histologically in one of our cases even three months after the onset of the retinal separation.

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EPITHELIAL TUMORS OF THE EYELIDS*

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This study is a review of the histologic and clinical aspects of tumors of the eyelids. It is reported as a plea against the indiscriminant use of the term "mixed" tumor in relation to eyelid tumors, and to indicate the need of classification of really unusual tumors, so that their nature may be more clearly defined by subsequent observers. We propose to evaluate a series of eyelid tumors as a basis for support or criticism of terms that have been applied to these tumors in the past.

CASE DATA AND ANALYSIS

Eighty-two cases of epithelial tumors of the eyelids were collected from the records of the Department of Pathology of Duke Hospital for the period 1930 to 1954. Only cases adequately documented and with from three to 24 years of follow-up were selected, although information for the maximum follow-up period was not always available. The 82 cases are listed in Table 1, together with the treatment employed, mortality, and known survival periods.

Among those cases where the race was known, 76 patients were Caucasians, two were Negroes, and one was an American Indian. There were 39 females and 38 males. The average age at which the patient first came to the hospital was 57.5 years, ranging from 17 to 87 years. Two patients were under 25 years of age. One patient, a 17-year-old white male, had a keratinizing form of basal-cell epithelioma which grew from a millimeter to one-half centimeter in size in the month prior to removal. The other young patient was an 18-year-old white female with a sudoriparous type of basal-cell epithelioma. These statics are similar to the sex and age distributions reported by other investigators.[1, 2]

The lower lid was involved in 43 cases; the upper lid in 16; the inner canthus in nine; and the outer canthus in six. The right eye was involved in 32 cases, and the left in 45.

Three degrees of clinical involvment were recognized: minimal, moderate, and extensive. Minimal involvement designated cases in which the tumor was confined to one lid or one canthus and had a diameter of less than one cm. at the time of the first visit of the patient to the hospital; moderate involvement designated cases with lesions larger than one centimeter but still confined to the site of origin and to the immediately adjacent skin; while extensive involvement designated tumors which had extended beyond the lids or canthi. Eighteen cases, or 22 percent of the whole group, were basal-cell epitheliomas with minimal involvement which had five-year cures; while two, or 2.5 percent were squamous-cell epitheliomas with original minimal involvement with five-year cures. Five-year cures were obtained in 13 of 20 basal cell and in one of three squamous-cell epitheliomas in the moderate involvement group; and in eight of 13 basal-cell and one of seven squamous-cell epitheliomas in the extensive involvement group. Of the 14 deaths due to tumor, six were due to

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TABLE 1

EPITHELIAL TUMORS OF THE EYELID

Type	Total No.	Involvement			Treatment				Survival*		Died of Carcinoma
		Min.	Mod.	Ext.	Exenteration	Enucleation	Radium or X-ray only	Local Excision	2 yr.	5 yr.	
Squamous carcinoma	15										
Well differentiated	2	1	1				1	1	2		
Moderately differentiated	10	4	1	5	6		2	2	3	6	5
Undifferentiated	3		1	2	1		1		2		3
Basal-cell carcinoma	67										
Primordial	39	19	13	6	7	1	11	18	5	30	4
Primordial with cysts	3	1	1	1				2		3	
Primordial and sudoriparous	8	2	3	3	2		2	3	1	7	1
Sudoriparous	6	4	2				1	5		5	
Sudoriparous and ribbon	1	1						1			
Ribbon	2			2	1		1			2	1
Pilar type proper	2	1	1				1	1	1		
Plexiform	1	1						1		1	
Tricho-epithelioma	1	1						1		1	
Unclassified glandular epithelioma	1	1						1			
Unspecified	3	1		2		2		1		2	

* Time from first appearance to last follow-up.

squamous-cell lesions with extensive involvement, six to basal-cell lesions with extensive involvement, and two to squamous-cell lesions with moderate involvement. An idea of the value of various types of treatment may be obtained by studying Table 1.

HISTOLOGIC CLASSIFICATION AND EVALUATION

Each tumor was classified into one of several categories: basal-cell carcinoma, squamous-cell carcinoma, meibomian-gland carcinoma, unclassified glandular epithelioma, and an unspecified basal-cell group where it was not possible to obtain satisfactory pathologic material to allow more specific classification. To avoid ambiguity, it is necessary to define in length just what is meant by some of the terms we used.

The squamous-cell carcinomas were divided into the well-differentiated, the moderately differentiated, and the undifferentiated. These subgroups corresponded to Broders' grade I, grades II and III, and grade IV, respectively. The basal-cell carcinomas were classified according to the subgroups recommended by Foot,[3] in order to recognize differences in prognosis among the various types of basal-cell lesions when catalogued as glandular or by other tumor patterns. They included all types of adnexal gland tumors which are found in the skin as well as the eyelid.

The categories suggested by Foot were the pilar type proper, primordial pilar, "ribbon" pilar, sudoriparous and plexiform.

Our use of these terms in this analysis does not mean that we suggest their use as common diagnostic terms. We found that many of the basal-cell epitheliomas of the eyelid showed several of Foot's histologic features rather than only one, and these were classified separately.

No histologic feature peculiar to eyelid basal-cell epitheliomas was discovered. For instance, such features as intercellular bridges, "ribbon" pattern, or primitive hair follicles were found in basal-cell epitheliomas of the skin of the rest of the body as well as eyelid. In no subcategory of basal-cell epithelioma was there a statistically significant number of cases, but no particular type appeared to be any more or less malignant than any other type.

We confined the use of the term "tricho-epithelioma" to those basal-cell epitheliomas having large cystic areas containing keratin as well as elements plainly resembling hair follicles but with a basal-cell epitheliomatous pattern, as described by Traenkle[4] (fig. 1).

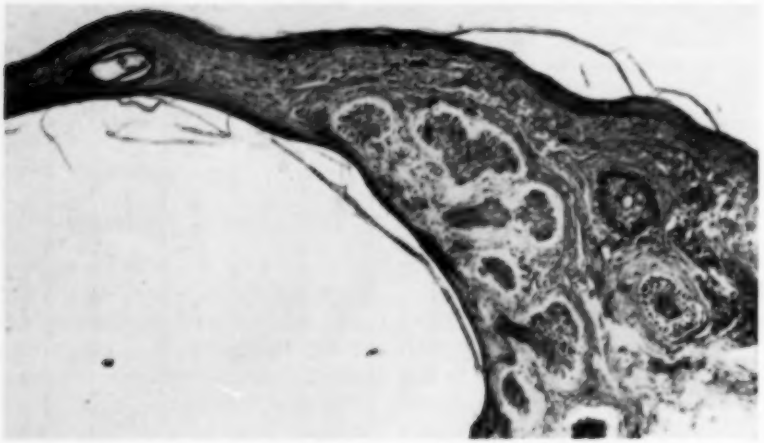

Fig. 1 (Smith and Brockman). Section of a tricho-epithelioma of the eyelid, showing a large keratin cyst on the left with smaller cyst above it. Basal-cell epitheliomatous elements and abortive hair follicles are on the right. (Case 48,978. ×90.)

This group merged into the "pilar type proper" basal-cell epithelioma, and included lesions that some may call "epithelioma adenoides cysticum of Brookes."

There are terms frequently used in connection with eyelid tumors which do not convey the same histologic picture to all readers. These are "mixed" tumors, and "adenoid cystic tumors."

The term "mixed tumor" has been applied by some authors to epitheliomas having both squamous and basal-cell components, and by other writers to mixed mesenchymal and epithelial tumors of the tear glands or skin of the eyelid. The mixed mesenchymal and epithelial tumor is rare in the eyelid and is identical in appearance to the mixed tumor of the salivary glands,[6] where both mesenchymal and epithelial elements have proliferated autonomously.

The term "mixed baso-squamous epithelioma" is specific and conveys the meaning to us that here one may find a histologic element that resembles basal-cell carcinoma and, in the same mass of tumor, elements which resemble squamous-cell carcinoma.

There are two possible ways for a pathologist to classify such a lesion: One is as "mixed baso-squamous epithelioma." The other is to interpret some of this mixed element as benign hyperplasia.

For instance, some basal-cell proliferation may occur adjacent to an obvious squamous-cell carcinoma. Or, squamous-cell hyperplasia, in the form of squamous pearls, hyperplastic rete or abortive hair follicles may occur in a lesion predominantly a basal-cell carcinoma (fig. 2).

It is also possible to confuse a plexiform basal-cell carcinoma with a plexiform squamous-cell carcinoma or vice versa, or to classify either as a "mixed epithelioma."

We suggest that neither of the terms, "mixed tumor" nor "mixed baso-squamous cell epithelioma," be used except in rare instances. These instances are the mixed mesenchymal and epithelial tumor for "mixed tumor" and instances of clear-cut, combined, malignant basal-cell proliferation and malignant squamous-cell proliferation for "baso-squamous cell epithelioma." In our 82 cases there was no "baso-squamous epithelioma."

We think a basal-cell epithelioma with a squamous epithelial hyperplasia or a squamous-cell carcinoma with basal-cell hyperplasia will behave clinically like a basal-cell or squamous-cell carcinoma respectively, and

these lesions should be so classified.

Pathologists and writers on the subject of eyelid tumors might confuse or contract "mixed baso-squamous epithelioma" into "mixed tumor" or use different criteria in diagnosing either. For instance:

Birge[6,7] studied a group of combined baso-squamous cell epitheliomas and referred to them as "mixed epithelioma." He reported studies on 32 patients with "mixed" lesions, of a total of 230 patients with epitheliomas of the eyelid, an incidence of about 14 percent.

Stetson and Schulz[2] found a 2.4 percent incidence of mixed basal and squamous carcinoma in 162 cases of eyelid epitheliomas examined microscopically; Hollander and Krugh,[8] 1.6 percent in 60 cases; Driver and Cole,[1] 8.2 percent in 109 cases; and Hunt[9] 4.9 percent in his cases.

Thus, the incidence of "mixed" tumors varied considerably, suggesting that different criteria for classification were used.

Another term applied to epitheliomas of the eyelid is "adenoid cystic" epithelioma. These confusing basal-cell lesions having adenoid characteristics were mentioned by Hagedoorn,[10] who found their classification difficult. They have been listed variously as five percent,[11] 6.4 percent,[5] and 1.2 percent[2] of epitheliomas examined microscopically, but in the latter two series, the category is not defined.

The term is confusing because of lack of definition of "adenoid cystic" by some authors, and different definitions by others. Martin[11] refers to this class only as "adenoid basal-cell carcinoma, a more malignant and potentially metastasizing tumor." Reese[12] catalogues adenoid cystic epithelioma as the tricho-epithelioma or hair-follicle type of basal-cell epithelioma, and states that it can be viewed as a benign basal-cell epithelioma. This definition is very clear, and, if generally accepted, would avoid confusion. Because of the different definitions of "adenoid cystic" epithelioma, it is preferred to use the term "tricho-epithelioma" instead.

There are certain rare glandular epitheliomas that cannot be classified properly as tricho-epithelioma or glandular sudoriparous basal-cell epithelioma, and it is perhaps tumors of this sort which some authors have in mind when they write of "adenoid cystic" lesions.

To merit separate classification, such tumors should not be meibomian-gland tumors, nor should they fit classic descriptions of sweat-gland (glands of Moll) or sebaceous-gland (glands of Zeiss) tumors, and

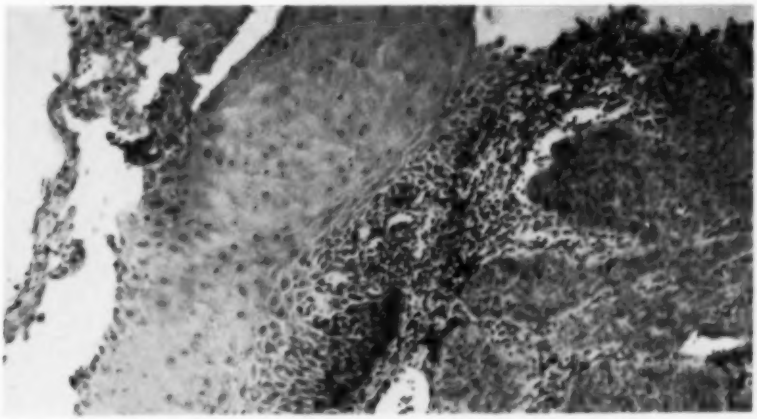

Fig. 2 (Smith and Brockman). Section of an eyelid basal-cell epithelioma with hypertrophic but benign squamous element on the left. This squamous element extends down from surface epithelium, which is not present. (Case 52,750. ×120.)

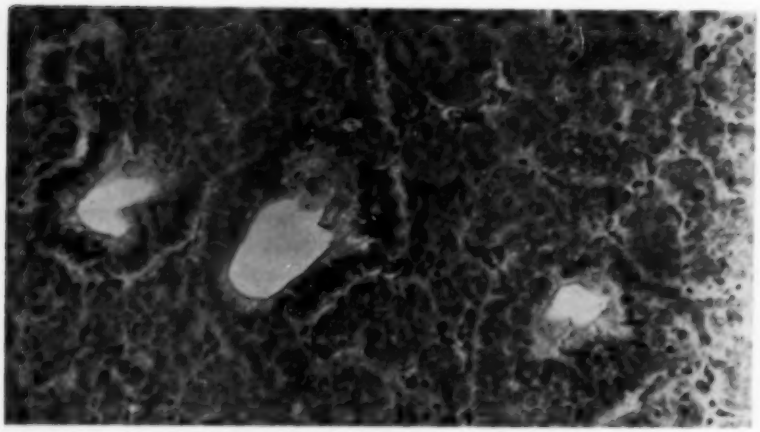

Fig. 3 (Smith and Brockman). Section of an unclassified glandular epithelioma with cords of cells of basal-cell epithelioma pattern and peculiar glands lined by a pseudostratified epithelium. (Case 44,344. ×200.)

they should have features that distinguish them from the usual types of basal-cell carcinomas. There was one such unusual glandular tumor in our group.

Histologically, certain large cystic areas and the epithelial component suggested the sudoriparous type of basal-cell epithelioma, yet other areas showed a small close glandular configuration and cysts lined by a columnar epithelium (fig. 3). It may be speculated that this tumor arose from gland ducts. Because of its peculiar configuration and our reluctance to classify it in any commonly recognized class, this tumor is referred to as "unclassified glandular epithelioma of the eyelid." The patient with this lesion died two months following biopsy from causes not related to the tumor, and nothing can be said of its prognosis.

In addition, one of our squamous-cell carcinomas had peculiar glandular or pseudoglandular areas (fig. 4), as well as

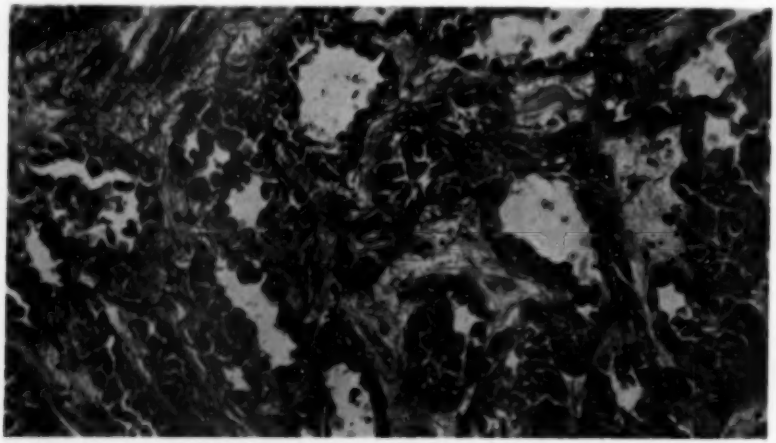

Fig. 4 (Smith and Brockman). An adenoid area of squamous-cell carcinoma. These pseudoglands contain no secretions. (Case A42,610. ×200.)

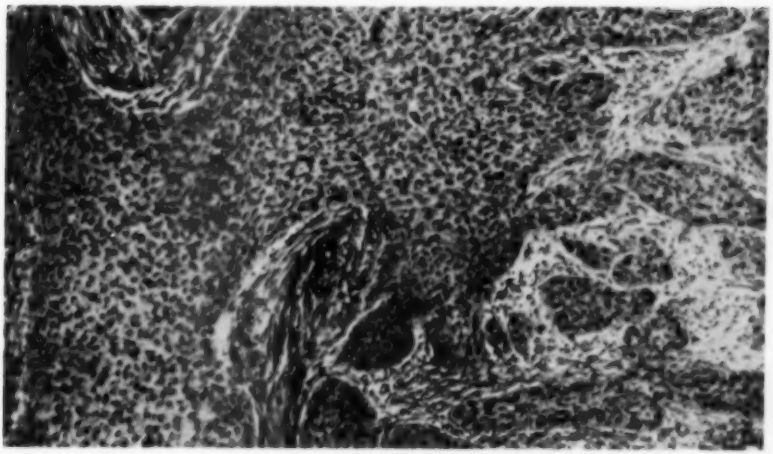

Fig. 5 (Smith and Brockman). Another area of the same tumor as shown in Figure 4, showing more typical solid masses and cords of squamous cancer. (Case A42,619. ×150.)

more typical solid areas of squamous carcinoma (fig. 5). The epithelium of the glandular component was not sebaceous in type and its pattern was not that of the usually described sweat-gland tumor.

We can speculate only that such tumors may be autonomous growths arising from epithelium related to the glands of Moll, Zeiss, or the meibomian glands. Further knowledge of the character of these tumors must await the finding of a series of such cases.

In our group of cases, there were no classic meibomian[10, 13] or sebaceous-gland tumors,[14] or sweat-gland adenomas or carcinomas.

Summary

1. A series of 82 tumors of the eyelids are classified by histologic types, degree of in-

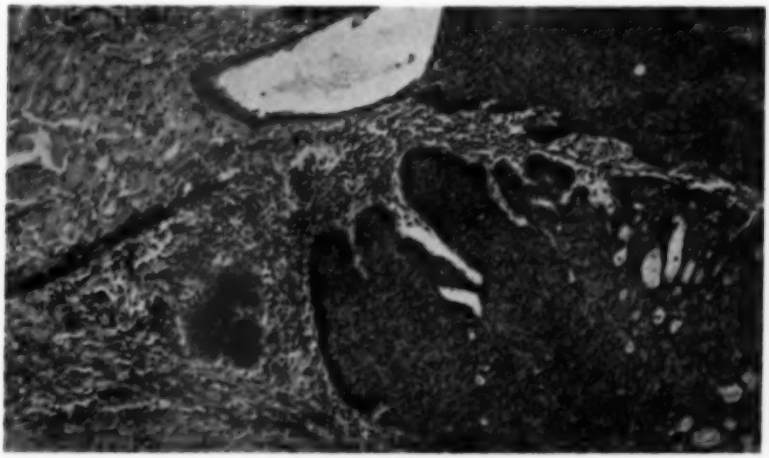

Fig. 6 (Smith and Brockman). A typical basal-cell epithelioma of the eyelid with primordial masses of tumor near the center of the section and sudoriparous elements on the right. (Case 70,105. ×90.)

volvement, type of treatment, and prognosis.

2. It is suggested that the terms "mixed" epitheliomas, "mixed baso-squamous epitheliomas" and "adenocystic" tumors be used rarely for eyelid epitheliomas and then only with clear definitions. These terms are confusing and each has been applied to several recognizable histologic entities. For clearer clinical connotation it is suggested that a "mixed" baso-squamous cell epithelioma should be classified as either basal- or squamous-cell carcinoma depending upon the most significant histologic pattern and probable clinical course. Further, it is suggested that the term "adenocystic" be avoided because of lack of present acceptance of its use for any single histologic entity.

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Ophthalmic Miniature

I may also add, that the prodigious number of blind persons to be met with in most cities of Germany, but particularly at Vienna, is generally accounted for by continental physicians from the use, or rather the abuse, of sour wines, and of strong liquors, rendering the appearance of cataract very frequent amongst the lower classes.

The Art of Preserving the Sight Unimpaired to An Extreme Old Age.

H. Colburn, London, 1816.

THE ROLE OF DEVELOPMENTAL ANOMALIES IN VERTICAL MUSCLE DEFECTS*

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The role of developmental anomalies as a causative factor in oculomotor imbalance has been recognized for many years.

Judging from available data, most of our knowledge of anomalous oculomotor defects relates to the horizontal mechanism. Surgery on the horizontal muscles is commonplace. During the operation, the area is widely exposed and abnormal formation of the muscle of fascial tissues is easily recognized. Thus, we have considerable evidence that anomalous development is actually the cause of an appreciable percentage of horizontal mechanical defects.

However, very little positive knowledge of anomalous formation of the vertical mechanism is available. Surgical procedures on these muscles are less frequently performed and the exposure is comparatively limited; therefore, the detection of abnormal formation is more difficult. Furthermore, lack of familiarity with the complex anatomy of this region makes comparison with the normal structure difficult.

Opinions vary concerning the importance of anomalous development as a cause of vertical defects. There are some who believe that a high percentage of vertical mechanical defects are due to abnormal development; whereas others consider them paretic in nature and that anomalous development plays a minor role. Such opinions are based on suppostion for the most part, because the cause of the mechanical defect is not determined in the great majority of instances.

With the hope of establishing a more definite basis for an opinion concerning the role of anomalous development in vertical defects, an attempt has been made to assemble some tangible evidence pertaining to them and to evaluate their role as a mechanical obstacle to binocularity. The review is by no means complete; it is rather an attempt to present some positive data in a comparatively unexplored field.

VERTICAL ANOMALIES: GENERAL CONSIDERATIONS

EMBRYOLOGIC BASIS

The embryologic development of the vertical mechanism is such that developmental anomalies are likely to occur. According to anatomists, anomalies related to these muscles can be explained on the basis of intrauterine errors in development of the premuscular embryonic mesoblastic mass. The extrinsic muscles and fascia of the eye are developed from a continuous mesodermal sheet. The normal oculomotor muscles represent a complete maturation of the developing mesoderm; the normal fascia represents a less complete development of the same mesoderm. Variations in development may occur because of failure of differentiation; this failure results in abnormal formations in the muscles or fascia which may vary from gross to minor anomalies.

It follows that the more complex and intricate the anatomic structure, the greater should be the possibility of incomplete maturation or variation in arrangement. If this is true, anomalous development should be more frequent in the vertical mechanism than in the horizontal because of the more intricate fascial formation associated with the complex vertical muscle relationship.

It is theoretically possible, therefore, to have a variety of abnormal formations involving the vertical muscles and their related fascia. The anomaly may involve either

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the muscle or fascia, or both; anomalies of the muscle relate to the muscle body, its origin, its insertion, and the plane of muscle action, while fascial abnormality may relate to the check ligament, fascial covering, fascial expansion, and fascial fusion.

Importance of vertical anomalies

There can be no doubt that a vertical anomaly creates a mechanical obstacle to binocularity and affects the position assumed by the eyes when innervational factors are excluded in so far as possible (when fusion is suspended and the refractive error corrected).

In the great percentage of instances the mechanical imbalance produced by these anomalies is neutralized by corrective fusional reflexes. Only when the anomaly is so pronounced that fusion has not sufficiently developed, or if it is weakened or artificially suspended, will the imbalance be manifested.

A disruption in the vertical mechanism, even though slight, creates a much greater mechanical handicap to binocularity than a similar degree in the horizontal defect. Recent years have brought a greater appreciation of the importance of the vertical mechanism. It is now generally recognized that the vertical mechanism plays a very significant role in binocular activity. Because of the anatomic arrangement and physiology of the vertical mechanism, a normal balance is essential.

It is of practical importance to determine the nature of the mechanical obstacle whenever possible. It is important to know whether the imbalance has as its basis a nerve involvement, trauma, or an anomalous state, because the surgical approach is frequently dependent upon the nature of the problem. While a true paresis due to a nerve involvement may require extensive surgical correction, an anomalous state may require merely the severing of an abnormal fascial fusion. Its recognition as the causative factor in a case, therefore, permits a more exact surgical correction which leads to a better final result.

Frequency of vertical anomalies

Although there is considerable variation in opinion concerning the frequency of vertical oculomotor anomalies, it is probable that many more of them exist than is usually supposed. In the horizontal region, where a free inspection is possible, we have ample proof of the presence of anomalous development, which can be determined even in mild degrees. Scobee,[1] who did an extensive study of developmental defects of the horizontal mechanism, stated that 90 percent of all cases of heterotropia appearing in the first six years of life have some underlying anatomic cause.

Because of the nature of the embryonic development, the vertical mechanism should show abnormal tendencies more frequently than the less complex horizontal mechanism. The frequency with which vertical anomalies are encountered in the dissecting room would lead one to believe that they occur more often than clinical reports indicate. Whitnall[2] states: "It is probable to judge from the writer's individual experience in finding quite a number of gross abnormalities of the ocular muscles in a series of dissections, that such are by no means as excessively rare as would appear from the number recorded in the literature; dissecting room conditions do not favor their identification, and in life some may be unrecognizable through compensatory action of the other muscles."

It is possible therefore, that vertical anomalies occur more frequently than is generally supposed; however, as matters now stand an estimate of the frequency of occurrence based upon actual observation is not feasible. More positive data which are based on a careful inspection of the area at the time of surgery are necessary. Even then an accurate estimate may not be possible because of the inaccessibility of the region.

Recognition of vertical anomalies

Preoperative examination

Anomalous vertical development can only occasionally be recognized as such in the preoperative examination. A positive preoperative diagnosis can usually be made in vertical anomalies of marked degree, such as are seen in Brown's syndrome, where the basis is obviously one of anomalous development. Positive preoperative diagnosis of anomalous development can be made only occasionally in cases of moderate degree. In cases of mild degree a positive preoperative diagnosis of anomalous development is not feasible.

In making a preoperative diagnosis of anomalous development, certain factors are suggestive:

1. The defect has been present since birth.
2. There is no history of injury or disease, such as pre- or post-partum infection.
3. There are no signs of central nervous system involvement.
4. The defect is mechanical in nature. (Such a mechanical defect in a muscle will cause the muscle to underact, so that findings at examination may simulate a paresis of the muscle. Proof that the abnormal position of the eye in these cases is based on a mechanical condition may be obtained by excluding, as far as possible, those innervations which may affect the position of the eyes relative to each other; for instance, by correcting any existing hyperopia and suspending the influence of the fusion apparatus.)
5. The forced duction test under anesthesia which reveals a limitation in movement is suggestive of anomalous development, especially if the condition has been present since birth and no other causative factor is present.
6. The "fixed muscle" duction test as advocated by Johnson may reveal the presence of an anomalous state. (Johnson[3] believes that the test is especially valuable in patients having the appearance of lateral rectus paralysis, superior rectus paralysis with overaction of the opposite inferior oblique, or superior oblique paralysis with head tilting. He has been able to demonstrate preoperatively that some of these cases are basically fusions between the muscle, which he terms "adherence syndrome.")

Johnson states that preoperative demonstration of the adherence is made by grasping the rectus muscle through the conjunctiva with one pair of toothed forceps (much as one would grasp the superior rectus muscle for inserting a bridle suture) and, with the other forceps, grasping the stump of the rectus muscle or the conjunctiva near the limbus. Even a fairly weak adherence will prevent more than a few degrees of forced rotation. He advises that this "fixed muscle" duction test be done prior to operation on all patients with the appearance of rectus paralysis. He concludes that congenital delayed development is the causative factor when this adherent area has been separated by external lysis (without opening the conjunctiva) and the patient obtains normal ocular rotation without evidence of reformation of the adherence.

In spite of the diagnostic measures, just mentioned it is evident that an anomalous development of the vertical mechanism cannot be diagnosed preoperatively with certainty except in a limited number of cases. However, in cases in which there is an obvious mechanical limitation of movement of the eye, in which the defect has been present at birth with no history of trauma, intrauterine disturbance or any evidence of central nervous system disturbance, anomalous development can be suspected. It is therefore apparent that the preoperative diagnosis of vertical anomalies is not usually conclusive.

Direct inspection

Examination of the region at the time of surgery is sometimes helpful in making a positive diagnosis of anomalous development. Although direct inspection is of value in horizontal defects, it has less value in the

vertical problems because of the comparatively limited exposure, which prevents adequate inspection of the complex anatomy. This inability to inspect the vertical region properly very likely accounts in part for the scarcity of reported instances of anomalous vertical development. Another factor which may account for the few cases reported is the failure to recognize an anomalous state in the vertical mechanism because of lack of familiarity with the normal anatomy of the area. This is understandable when one realizes the complex anatomy of the vertical mechanism, which is vaguely understood by most surgeons, or has not been studied in detail for some years.

One must conclude that even direct inspection at the time of surgery does not reveal the true basis in most vertical problems because many of the minor and moderate degrees of maldevelopment may not be detected.

It seems evident that the diagnosis both preoperatively and at the time of surgery is not possible in many cases of vertical developmental anomalies, and their presence can only be surmised.

Types of vertical anomalies

In discussing the various anomalous formations associated with the vertical mechanism, no attempt will be made to cover the subject completely. Rather, certain anomalies of the vertical muscles and their associated fascia will be discussed; these will serve to indicate in a general way the more common types encountered.

The subject will be presented in two parts: (1) Anomalous development related to the vertical muscles; (2) anomalous development related to the associated fascia.

Anomalies related to the vertical muscles

Developmental anomalies of the vertical muscles will be considered under the following heads: anomalies of the muscle (absence, accessory, fibrosis); anomalies of the muscle insertion; anomalies of the plane of action of the muscle.

Absence of a vertical muscle

Evidence obtained from a partial survey of the literature indicates that absence of a vertical muscle is a rarity, and is a negligible factor in evaluating the cause of the mechanical defect.

Judging from the number of cases reported, total absence of an oblique muscle is exceedingly rare. Posey,[4] in 1923, in an excellent review of extrinsic muscle anomalies, cited but one instance in which the oblique muscles were reported absent (Harles, 1880). Duke-Elder[5] mentions Cazeau (1833), who reported the absence of both superior obliques. According to Anderson,[6] Seiler reported absence of the oblique muscles. Undoubtedly other cases have been reported but these were not encountered in a partial review of the literature.

Judging from the literature, absence of the other vertical muscles is more frequent. To cite a few of the reported cases: Casten[7] encountered congenital absence of the inferior rectus muscle and was able to find 10 other cases reported in the literature. McDannald[8] described absence of the inferior rectus muscle which was proved by operation. Posey[4] reported the inferior rectus muscle absent except for a rudimentary portion at the usual site. Stieren[9] described absence of one inferior rectus muscle, and Davis[10] absence of both inferior rectus muscles.

Steinheim[11] reported a case of absence of the superior rectus muscle. Natale[12] reported a case of congenital strabismus in which both the superior rectus and inferior rectus muscles were found to be absent at operation. Coover,[13] in operating on a woman in an attempt to advance what he thought were paralyzed superior and inferior rectus muscles, found them absent. Klincosch[14] reported absence of all the ocular muscles.

Accessory or rudimentary vertical muscles

Such deviations from the normal formation may be considered a rarity if one is to judge from the literature. Such anomalies may be present more frequently than usually believed but, because of their inaccessibility, may be overlooked at the time of surgery. The dissecting room offers a greater opportunity to discover them and most of the reports are based upon such a source.

The following are some of the possible variations:

1. Superior oblique muscle. The muscle may end at the trochlea, or a normal superior oblique may be accompanied between the eyeball and the pulley by an extramuscular slip which has a common insertion with it upon the eyeball.

The superior oblique may be closely accompanied by an off-shoot from the levator palpebrae superioris (fig. 1). In a specimen of Whitnall's[2] there were two long muscle bundles, arising in common with the levator and ending anteriorly, the one upon the fascia bulbi between the superior oblique and the globe, the other on the orbital margin beneath the pulley; the nerve supply came from the fourth nerve; the superior oblique was broader than usual. He also described a slip passing from the medial border of the levator to the pulley of the superior oblique.

Ledouble[15] found supernumerary fasiculi accompanying the reflected tendon, and has further recorded a case where the direct or normal fleshy part of this muscle was absent, the reflected or usually tendinous part being muscular and arising from the site of the pulley, recalling the type normally found in nonmammalian vertebrates. According to Prangen,[16] two instances have been found in the human in which the superior oblique muscle ended in a common tendon with terminal nasal fibers of the superior rectus muscle.

This type of anomaly very likely is more frequent than reports in the literature indicate.

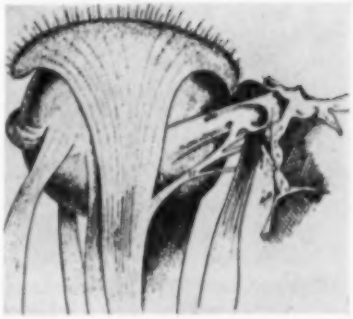


Fig. 1 (Fink). Anomaly of the levator muscle (from Posey). Drawing of the left eye showing an anomaly of the levator muscle which involves the sheath of the superior oblique muscle.

2. Inferior oblique muscle. Some variation in the point of origin of the muscle has been observed. As a rule, it is usually adjacent to, or rarely more than three mm. from, the incisura lacrimalis. Whitnall[2] examined 100 orbits, and found the interior oblique to have an origin in the usually described position immediately adjacent to the incisura lacrimalis of the maxilla in 45 instances; it was from two to five mm. distant from the incisura lacrimalis of the maxilla in 47 cases (most often in the left orbit); and it was from six to seven mm. lateral to the normal position in eight cases. In three of the eight cases the muscles were found to be inserted higher than usual, in a position resembling that found in certain fishes; their total length was normal.

Remington[17] encountered one case in which the origin was at least five mm. lateral to its usual site. White[18] described a two-headed origin—one origin was normally placed, while the other was several millimeters lateral to it.

In the series of 25 specimens examined by me, the position of the origin varied a few millimeters, but, as a whole, the point of origin was normal.

An abnormal muscle bundle (musculus obliquus accessorium inferior) is occasionally observed (fig. 2). Rex[19] reported an abnormal muscle bundle passing from the apex

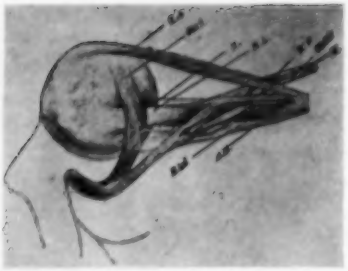


Fig. 2 (Fink). ANOMALY OF THE INFERIOR OBLIQUE MUSCLE (from Posey). Drawing of the left eye showing an anomaly of the inferior oblique muscle. It is referred to as an accessory muscle.

R. e., lateral rectus
Obl. i., inferior oblique
N., optic nerve
R. i., inferior rectus
R., int., medial rectus
III, third nerve
Obl. i., nerve branch to inferior oblique
A.M., anomalous muscle
Obl. i., nerve to inferior oblique

of the orbit to the inferior oblique, also sending a slip to join the inferior rectus; the anomaly was found in both orbits and was supplied by the third nerve.

An important anomaly which involves both obliques is referred to as "voluntary propulsion of the globe."

The point of crossing of the inferior oblique and the inferior rectus shows considerable variation in the degree of fusion; some specimens are firmly, others loosely, fused. Abnormal fusion of the inferior oblique with the lateral rectus muscle has been noted quite frequently. These fusions however appear to be fundamentally fascial in character and will be considered later.

3. VERTICAL RECTUS MUSCLES. Anomalies of the vertical recti are chiefly supernumerary slips of muscle tissue.

According to Scobee,[1] abnormal muscle slips may rise well back in the orbit and diverge slightly from the course of the muscle, which is their apparent source, to become inserted into the globe at a point somewhat behind and to one side of the insertion of their parent muscle (fig. 3); or be composed of an abnormally large collection of muscle fibers in the intermuscular membrane. The latter condition is by far the more common. Abnormal muscle slips appear in association with the rectus muscles in the following order of frequency: superior rectus, lateral rectus, medial rectus, and inferior rectus.

These anomalies were found in but a portion of the literature It is probable that anomalies of the vertical muscles are more frequent than published reports would indicate.

Fibrosis

Extrinsic muscles are occasionally found to be relatively inelastic. Two types of these inelastic muscles are seen; in one the muscle is congenitally abnormal in structure and incomplete maturation has occurred; microscopic examination shows an overabundance of fibrous connective tissue with a decreased amount of elastic tissue. In the other type of muscle the reduction in elasticity is not due to a maldevelopment, but rather is due to the muscle being constantly prevented from relaxing adequately. Eventually it becomes slightly inelastic. For example, the

Fig. 3 (Fink). ANOMALY OF THE SUPERIOR RECTUS MUSCLE (from Scobee). Schematic diagram of the right eye as viewed from above showing the insertion of an abnormal muscle slip laterally and somewhat posteriorly. The slip appears to have arisen back in the orbit from the superior rectus but, since this is not certain, no definite origin is shown.

so-called overfunction of the inferior oblique may be a secondary contracture, following paralysis of the superior oblique of congenital or early origin.

Present interest centers on the first type, in which the muscle development is anomalous. In such muscles the degree of maldevelopment is variable. In some cases the muscle shows but little increase in fibrous tissue; in others the muscle tissue is practically replaced by a fibrous band (Duane's syndrome).

The fibrosis may not be confined to the muscle tissue but may also involve the surrounding fascia to a variable degree. In mild cases only the muscle sheath may be involved. In more pronounced cases the process may involved also the intermuscular membranes which extend beyond the muscle sheath. The process may also extend backward into the orbit.

That the fibrosis may involve the surrounding fascia is evident in operating on these cases. If such a muscle is severed from the globe, resistance to rotation may still be present, showing that the process also involves the fascial tissue surrounding the muscle. Unless the fascial tissue is also severed the effect of the muscle operation is limited. It is therefore evident that in many of the so-called cases of fibrosis of the muscles we are dealing with an abnormal fascia as well.

Fibrosis of the horizontal muscles is relatively common in mild degrees. In such cases the muscle, when inspected at the time of operation, seems shortened and less elastic than the muscles normally found. Such mild cases are usually seen in children who have had the defect from birth. In more severe cases the whole picture is accentuated and may take on the characteristics of Duane's syndrome.

Such fibrosis also occurs in the vertical muscles in varying degrees and may be associated with fibrosis of the horizontal muscles. It can involve any of the vertical muscles, and if mild is not evident and can be easily overlooked. If pronounced it will of course be evident, and will present many of the features characteristic of Duane's syndrome. As in the horizontal recti, the anomalous development is not confined to the vertical muscle only, but involves the adjacent fascia to a greater or lesser degree.

The so-called "vertical retraction syndrome" mentioned by Brown[29] is an example of a congenital maldevelopment involving the vertical recti. Brown considers the condition to be due to congenitally paralytic superior and inferior rectus muscles of the same eye, and suggests the presence of limiting fibrous bands in the vertical recti.

It is my opinion that such anomalous development is more common than the literature indicates. Because of the nature of the anatomy in the region of the vertical muscles a wide exposure of the area at surgery is not possible and as the result the nature of the anomaly may be overlooked. It is especially difficult to evaluate the character of the tissues in defects of mild or moderate degree.

It seems, therefore, that fibrosis of the vertical muscles is of significance in considering anomalous devolpment and plays a role in certain cases in creating a mechanical imbalance.

Anomalies of muscle insertion

Abnormal insertion of the vertical muscles may be considered in the category of developmental anomalies.

Although variation in the insertion of the vertical muscles may be sufficient to cause a mechanical problem, our evidence as to its actual role is difficult to evaluate. Because of the comparative inaccessibility of the insertion of a vertical muscle, anomalies are difficult to detect and very likely are frequently overlooked. As certain data seem suggestive, however, discussion of anomalous insertions seems warranted, even though much of it is in the realm of speculation.

Superior oblique

Anatomic study shows that the insertion of the superior oblique tendon is the most variable of all extrinsic muscle insertions. This marked variability is dependent chiefly upon two factors, namely, the variable length of the superior oblique insertion and the variable angle of its insertion.

In 100 specimens examined by me the average length of the insertion was 11 mm. Seventy-three of these specimens showed an length of 10.8 mm., with measurements ranging between nine and 13 mm. Of the remaining 27 specimens, three were seven mm., 10 were eight mm., six were 14 mm., five were 15 mm., two were 17 mm., and one was 18 mm. In addition to this marked variation in the length of the insertion, the variable angle of insertion should be emphasized. Such a condition may produce an abnormal line of pull, which in pronounced variation from the average could conceivably create a mechanical problem.

There were two types of insertions: in one the line is broad, with a strongly marked anterior concavity, lying in an equatorial direction across the vertical meridian with the greater part on its lateral side; the other is narrower and flattened, and lies entirely in the lateral quadrant almost parallel to the vertical meridian.

It is difficult to estimate the importance of an anomalous insertion of the superior oblique. Although most of the variations in development are undoubtedly compensated for and the abnormal effect is neutralized, there are some which may not be fully compensated for and which therefore produce a mechanical obstacle to a greater or lesser degree. Because of the inaccessibility of the superior oblique insertions, it is difficult for the surgeon to recognize their presence and to evaluate their true role in creating a mechanical obstacle.

Inferior oblique

The insertion of the inferior oblique, through variable, is more uniform than that of the superior oblique. The variation consists chiefly in the degree of obliquity and convexity of the curve. The insertion often shows gross irregularities, such as angular serrations or dehiscences.

The length of insertion of the inferior oblique muscle in 100 specimens averaged 9.6 mm. In 93 cases the average was 9.5 mm., the measurements varying between eight and 10 mm. Of the remaining cases one was five mm., one was seven mm., two were 12 mm. and two were 14 mm.

It is possible that a marked variation in the insertion of the inferior oblique can create a mechanical problem, especially if associated with other abnormal factors affecting the surrounding fascia. Such a variation may place the inferior oblique muscle at such a disadvantage that it cannot counterbalance the effect of the superior oblique.

Although the surgeon can inspect the insertion of the inferior oblique to some degree, the recognition of an abnormal insertion is difficult and uncertain. Because of this, positive data concerning the role of the abnormal insertion in producing a mechanical defect is very limited.

Vertical recti

Very little data are available concerning abnormal insertion of the vertical recti. In my experience there is less variability in the recti insertions than in the insertions of the obliques.

A study of anatomic material showed some variation in the length of the insertions of the vertical recti which does not seem significant. The more posterior locations of a few vertical insertions were suggestive of a sufficient departure from normal to create a mechanical problem, and suggested a cause for the underaction of the muscle. Some variation in the insertion in relation to the anterior-posterior medial plane was noted and raised the question as to their importance in producing abnormal action.

As a whole, insertional variations of the vertical recti, as seen by me, do not seem of

Fig. 4 (Fink). ANOMALY OF THE INSERTION OF THE SUPERIOR RECTUS (from Scobee). Schematic diagram of the right eye as viewed from above showing an abnormal insertion of the right superior rectus. The usual insertion is extended laterally and posteriorly in a curve. The extra insertion contains muscle fibers.

sufficient degree to be considered anomalous except perhaps for the instances mentioned above, where the insertion was more posterior than normal.

Scobee[1] described an abnormal insertion in which the superior rectus had a normal insertion. A thick band of muscle fibers was in the intermuscular membrane toward the lateral rectus and had a curving insertion into the sclera which extended laterally from the insertion of the superior rectus (fig. 4).

Preoperatively the case resembled one of paresis of the inferior rectus. When the forced duction test was applied, definite resistance to infraduction was found.

ANOMALIES IN THE PLANE OF ACTION

Abnormal plane of action of a vertical muscle should be considered in discussing developmental defects. Such abnormal development cannot be determined preoperatively or at the time of operation. It is a condition which is found in the study of anatomic specimens. Because of this it can be considered only as speculation, although clinically, certain abnormal muscle action can be explained on this basis. Since, from the evidence at hand, it appears that this factor applies chiefly to the oblique muscle, the discussion will be confined to this aspect of the subject.

Because the obliques are usually inserted in different positions on the globe, the oblique muscle planes do not exactly coincide. However, most observers consider that for practical purposes the muscle planes should be regarded as the same, making an angle of about 51 degrees with the visual line. Any mechanical difference in the plane of action is neutralized by the adjustment capacity of the central mechanism. Undoubtedly, this is true in eyes in which slight deviation exists but in cases in which there is a greater degree of deviation there is a question as to the validity of this assumption.

In a series of specimens studied by me,[21] measurements of the relation of the two obliques varied sufficiently to cause me to question such a supposition. In 122 adult human specimens, measurements were made of the relation of the planes of action of the two obliques to one another, and of their relation to the anteroposterior vertical plane of the eyeball.

Although the average angle which the planes of action of the superior and inferior obliques made with the anteroposterior vertical plane of the eye was about 45 degrees in this series, a study of individual specimens revealed in many instances an appreciable variation in the muscle plane of one oblique as compared with the other (fig. 5). They varied sufficiently to raise a question as to a balanced action between the two muscles. It is apparent that other factors must act to compensate for the difference in the two planes of action in most instances of this type.

In higher degrees of variation, however, as found in some of the 22 specimens showing greatest variation, it is possible that such a condition may create a mechanical obstacle to binocularity and, when associated with other etiologic factors, may be sufficient to produce a deviation.

It seems that a congenital maldevelop-

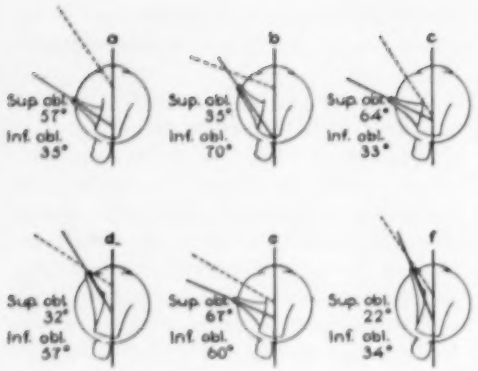


Fig. 5 (Fink). Drawings of specimens in which there are pronounced variations of the oblique muscle planes of action. Continuous line indicates the superior oblique plane of action. Broken line indicates the inferior oblique plane of action.

ment in the planes of action of the oblique muscles is as logical an explanation as any for certain abnormal actions of the vertical muscles. The resulting physiologic imbalance of the opposing obliques, coupled with an appreciable imbalance in the planes of action of the obliques in their relation to the anteroposterior vertical plane of the globe, may produce an upshoot or abnormal action of the inferior oblique when the eye is adducted.

Also, it is possible that certain cases of muscle imbalance, especially those seen in convergence and divergence anomalies, can be due to a mechanical defect in the oblique muscle planes, with the horizontal defects as secondary factors.

Such explanations are admittedly speculative, but based upon the above data, there is some tangible basis for them. These explanations may help to clarify some of the uncertain phenomena related to the complex etiology of the vertical defects.

Fascial anomalies associated with the vertical mechanism

A study of available data indicates that there is little positive information available concerning fascial anomalies of the vertical mechanism.

Although our knowledge of these anomalies is not for the most part based on actual observation, their presence is suspected because of the mechanical problems encountered in this area which are logically explained on this basis.

It has been demonstrated by Scobee[1] and others that abnormal fascial formation is associated quite frequently with the horizontal muscles. Because fascial anomalies are obviously present in the horizontal field, it seems logical to expect their presence in the vertical field also. Due to the more complex anatomy of the vertical fascia, there is greater reason for abnormal development here than in the horizontal area. Because of the limited exposure of the vertical area for inspection at the time of surgery, in addition to the complex nature of the normal anatomy, it is possible that many of the fascial anomalies in this area are overlooked, especially those of minor degree.

With the hope of establishing a more definite basis for an opinion, the following discussion will present some tangible evidence which is based in part on personal experience. Although the evidence is admittedly limited and therefore inconclusive, it will indicate some of the various possibilities and thus may serve as a basis for further study.

Fascial anomalies associated with the vertical rectus muscles

For the purpose of presentation, the abnormal fascial changes related to the vertical recti may be divided roughly into two groups. In the first group, the anomaly is limited to the fascia. In the second group, the fascial anomaly is associated with structural changes in the rectus muscle.

I. Anomalies limited to the fascia of the vertical rectus muscles

Anatomic considerations

A review of the normal fascial arrangement of the area will serve as a basis for comparison with the abnormal.

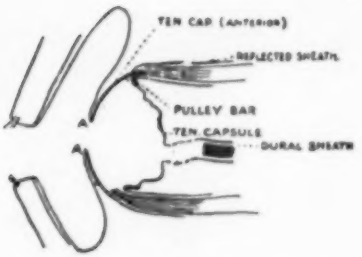


Fig. 6 (Fink). Diagram to show the fascia bulbi (Tenon's capsule) after excision of the eyeball (from Whitnall).

1. Superior rectus. Normally, the arrangement of the fascia in the region of the superior rectus insertion is as follows: The anterior portion of the superior rectus muscle is completely encircled by a fascial sheath, which expands both laterally and medially to fuse with adjacent structures. The fascial sheath is firmly fused to the fascia bulbi at the point of insertion of the rectus muscle, and this fascial fusion is referred to as a "pulley" or "the falciform fold" (fig. 6).

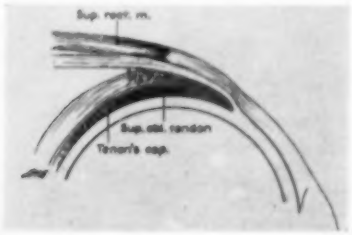
The fascial sheath of the superior rectus is fused above with the inferior fascial covering of the levator, forming a firm union. The fusion with the levator fascia begins six to seven mm. posterior to the insertion of the superior rectus muscle and is present wherever the sheaths of the levator and the superior rectus are in contact.

The fascia covering the undersurface of the superior rectus tendon and muscle is in contact with the fascia bulbi, which covers the superior oblique tendon and the globe (fig. 7).

If the muscle is severed and the cut end turned forward, the inferior fascial covering of the rectus muscle and the fascia bulbi covering the globe are seen to be separate membranes fused together by fibroelastic bands (fig. 8). Normally, these bands can be easily broken and the two membranes completely separated.

In the study of a group of specimens, certain variations in the fascial arrangement occurred which are suggestive of the process which may occur in anomalous formations. In separating the fascial layers covering the undersurface of the superior rectus tendon from the fascia bulbi covering the superior oblique, more difficulty was encountered in some specimens than in others. In most of the specimens the two fascial membranes were loosely blended; a few specimens showed a firmer union and were difficult to separate. Making allowance for postmortem changes, it was evident that the degree of fusion varied. An increase of this fusion could produce an anomalous formation which would act as a mechanical obstacle to binocular action.

2. Inferior rectus. The normal fascial arrangement in the region of the inferior



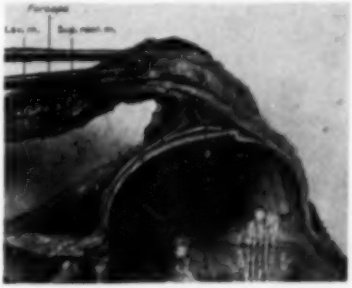
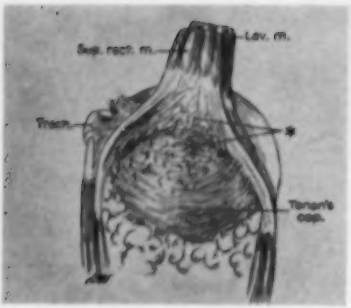


Fig. 7 (Fink). Relation of the fascia bulbi to the superior oblique tendon and to the fascial sheath of the superior rectus. The fascia bulbi overlies the superior oblique tendon, adhering to it and the surrounding sclera by delicate and numberous fibroelastic bands or trabeculae. The fascia bulbi continues forward of the line of insertion of the superior rectus muscle and fuses with the sheath covering the undersurface of the superior rectus muscle.



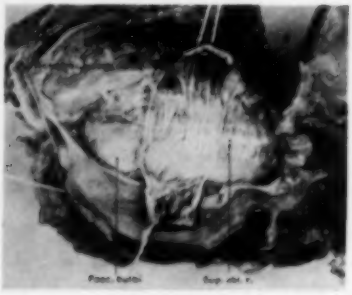


Fig. 8 (Fink). Relation of the fascia on the inferior surface of the superior rectus muscle to the fascia bulbi covering the eyeball. Viewed from above. The superior rectus muscle is severed and the cut end is turned forward, revealing the fusion between the sheath of the superior rectus and the fascia bulbi. These are separate membranes fused by fibroelastic bands; the bands can be broken and the two membranes entirely separated. *Area of fusion between the fascia bulbi and the fascia of the superior rectus muscle.

rectus insertion is as follows: The anterior portion of the inferior rectus is invested with a fascial sheath and has expansions which extend laterally and medially to blend with the surrounding fascia. At the point of insertion of the muscle the fascial covering becomes firmly fused to the fascia bulbi, forming what is called the "falciform fold." The upper surface of the fascial sheath of the inferior rectus is fused to the adjacent fascia bulbi, which surrounds the eyeball. This fusion is loose and normally the two membranes can be easily separated.

The fascial covering of the undersurface of the inferior rectus is in contact with the fascial covering of the inferior oblique. The fascial sheath on the undersurface of the inferior rectus muscle becomes definitely thickened in the few millimeters' distance before it reaches the inferior oblique and, at the point where the muscles cross, this thickened fascia comes in contact with a similar thickening of the fascia covering the inferior oblique. A fusion is brought about by numerous fascial bands passing from one fascial sheath to the other (fig. 9).

Study of a series of specimens suggests that the degree of fusion between these fascial sheaths is variable. Some specimens showed a very firm union, even a complete fusion, of the fascial sheaths (fig. 10). Others showed a very loose fusion, there being but a few bands of fibrous tissue connecting the two fascial muscle sheaths, which could be separated with ease (fig. 11). Between these two extremes there was a group of specimens in which the union between the sheaths was moderate. In these, the fascial strands, although firmly uniting the two muscle sheaths, did not completely fuse them.

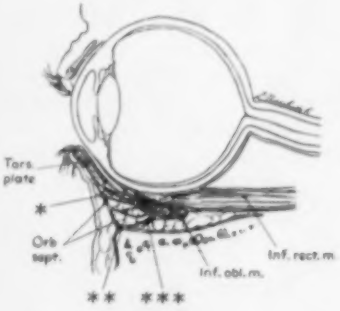


Fig. 9 (Fink). Fascial arrangement at the crossing of the inferior rectus and inferior oblique muscles. Sagittal section through midplane of the eyeball. The fascia in this area is part of the suspensory ligament of Lockwood. An important feature is the fusion of the sheaths of the inferior oblique and inferior rectus muscles. *Fibrous bands extending to the tarsal plate. **Fibrous bands extending forward to the orbital septum. ***Fibrous bands extending to the periosteum on the floor of the orbit. These are usually not direct extensions but are made up of the fibrous meshwork which surrounds the fatty tissue.

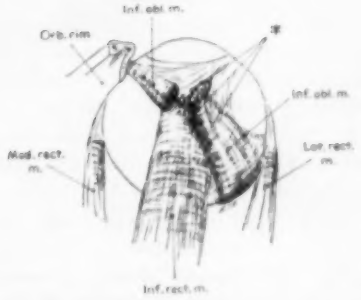


Fig. 10 (Fink). Fascial arrangement at the crossing of the inferior rectus and inferior oblique muscles. Viewed from below. An important modification of the suspensory ligament of Lockwood is found at the crossing of the inferior rectus and inferior oblique muscles. Anatomic material reveals that a fusion exists between the fascial sheaths of these muscles at this point. A fusion is brought about by numerous fascial bands which pass from one fascial sheath to the other. In the drawing the inferior oblique muscle is severed and turned laterally, showing a firm union between the fascial sheaths of the two muscles. Short, thick bands of fibroelastic tissue at the crossing of the muscles result in practically a complete fusion between the muscle sheaths, with very little, if any, independent action of either muscle. *Short, thick fibrous bands between the inferior rectus and inferior oblique muscles.

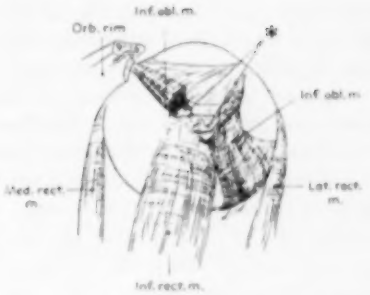


Fig. 11 (Fink). Fascial arrangement at the crossing of the inferior rectus and inferior oblique muscles. Viewed from below. The inferior oblique muscle is severed and turned laterally, exposing a loose fusion between the fascial sheaths of the two muscles. *Long, delicate, loose bands of fibroelastic tissue which permit considerable independent motion of either muscle.

In the specimens examined, the degree of independent movement of the two muscles was in proportion to the degree of fusion between their fascial coverings. In those showing a firm union, there seemed to be no apparent independent movement of the two muscles, and the impression of a solidly fused structure was given. In those having a loose fusion, the independent movement of the two muscles was very definite. As would be expected, the specimens between these extremes showed variable amounts of movement, proportionate to their degree of fusion. The majority of the cases fell into this latter category.

Although it is obviously impossible to compare with any exactitude prepared anatomic material and similar structures in the living, such anatomic material may give us a basis for comparing different degrees of fusion.

An anatomic study therefore presents some evidence that there is variation in fascial development as related to the rectus muscles. Although one cannot conclude that such variation is indicative of anomalous fascial changes, it does suggest itself as the basis for anomalous changes if carried to a greater degree, so that it acts as a mechanical obstacle.

Clinical Data

Evidence of anomalous formations which relate to the fascial sheath of the vertical rectus is limited if one is to judge from the literature.

There is some evidence, however, which indicates that such anomalies occur. For example, Johnson[3] described an anomalous fascial formation of the superior rectus which he termed "adherence syndrome." He considered it a manifestation of faulty development of the loose, physiologic attachments between the fascial sheath of the superior rectus and the fascial covering of the superior oblique. He found that in the superior rectus adherence syndrome, elevation of the globe was limited because "the functional attachment of the superior rectus becomes that attachment of the superior oblique and was so far posterior that even powerful efforts at elevation could not elevate the globe, but could retract only slightly

the posterior pole." In his cases, the clinical appearance was that of paresis of the adherent superior rectus, with overaction of the opposite inferior oblique. "This is demonstrated most obviously when there is a clinical diagnosis of bilateral rectus paralysis, with overaction of one or both inferior oblique muscles. Here the true etiologic factor frequently is adherence of one or both superior rectus muscles to the corresponding superior oblique muscle."

He considered the finding of adherence between the superior rectus and the superior oblique muscle to be of great surgical importance, because the best functional result follows lysis of this adherence, rather than a procedure designed to weaken the opposite inferior oblique. In his experience, isolated adherence of the superior rectus to the superior oblique is occasionally found, and this adherence is usually seen accompanying adherence of the lateral rectus to the inferior oblique.

In my experience, anomalies of the fascial sheath of the vertical rectus which could be positively identified have been limited in number.

In six instances I have found variation in connection with the fascial sheath of the superior rectus which suggested to me the anomalous state as described by Johnson. In these cases the following changes were noted:

The anterior fascial covering of the superior rectus and its fascial expansions appeared normal. The line of insertion of the muscle appeared to be normal in position, length, and direction. The muscle was normal both in size and elasticity.

When the linear insertion of the muscle was severed, a firm fusion of the undersurface of the muscle sheath to the underlying fascia bulbi was found. This fusion, most pronounced at the muscle insertion, extended posteriorly for a distance which varied in different cases (fig. 12). This fusion created a firm thickened adhesion of the muscle to the underlying fascia bulbi. The

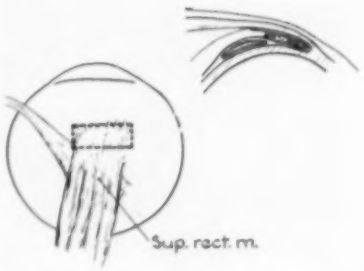


Fig. 12 (Fink). Drawing showing the location of anomalous formations in the region of the insertion of the superior rectus. There was a firm fusion of the undersurface of the superior rectus sheath to the underlying fascia bulbi starting at the falciform fold and extending posterior for a few mm. The superior oblique tendon and the trabeculae surrounding it were not involved to any degree.

superior oblique tendon and the trabeculae surrounding it were involved to a moderate degree; the involvement was most pronounced near the medial margin of the superior rectus where the oblique tendon comes closest to the superior rectus insertion.

This fusion between the sheath of the superior rectus and the fascial covering of the superior oblique seemed to be a factor in restricting the vertical movements of the globe, and was apparently due to the fact that the functional attachment of the superior rectus muscle was posterior to the normal point of insertion. In these cases the action of the superior oblique was not appreciably impaired.

Although the restriction in movement of the globe was most evident in the field of action of the superior rectus, the more pronounced cases also showed some limitation in outward and downward rotation of the globe.

In all instances hypertropia was present, although such a condition when moderate would doubltess produce a mechanical obstacle of lesser degree in which a hyperphoria would be found.

The study of the findings of a specific case will serve to illustrate the typical changes present. The patient was a child

who had strabismus from birth. There was no history of injury, intrauterine inflammation, or evidence of central nervous system involvement. The strabismus was convergent and unilateral, with an associated underaction of the superior rectus. The eye was limited in its rotation outward and upward when the forced duction test was performed under ether. When the medial rectus was exposed, it was found to be inelastic. After the insertion was severed, the eye continued to be somewhat restricted in outward movement and it was not until the fascial expansions were severed that a full outward rotation of the globe was possible.

As the vertical rotation was limited upward in the field of action of the superior rectus, an exploration of this region was made. Examination of the area showed a definite thickening and firm fusion of the fascial sheath of the superior rectus to the fascia bulbi. The fusion began at the insertion of the superior rectus and extended posteriorly for about five mm. The superior oblique tendon did not appear to be involved in the process to any appreciable degree. When the restricting bands were severed, the eye could be freely rotated upward.

The anomalous fascial changes described above occurred also in the inferior rectus. However, fascial changes related to the inferior rectus were more rare (two cases).

II. *Associated anomalies of the fascia and the vertical rectus muscle*

In the second group of fascial anomalies related to the vertical recti, both fascia and muscle were involved. Only three cases were seen by me in which both a vertical muscle and fascia had anomalous changes. Two of these cases were pronounced and resembled the cases reported by Brown[20] in his description of the "vertical retraction syndrome."

The process resembled the previously described fascial anomalies as to location, but showed an accentuation of the fascial thickening and fusion. In addition there were typical fibrotic changes involving the rectus muscle, such as are encountered in fibrosis of the horizontal muscles. Fibrosis of the rectus muscles and adjacent fascia can involve the vertical region alone, or the process can be associated with similar changes in the horizontal region.

Fascial anomalies associated with the superior oblique muscle

That fascial anomalies are the cause of abnormal action of the superior oblique is clear, although we have very little positive evidence to substantiate such a claim. A discussion of the subject is limited in its value because the literature yields very little data and I must draw upon personal experience which is admittedly limited. It will serve, however, as a tangible basis for the discussion.

Anatomic considerations

A review of the normal fascial arrangement of the area will serve as a basis for comparison with the abnormal.

For the purpose of presentation the fascial membranes covering the reflected tendon of the superior oblique may be divided into two parts; the part from the trochlea to the medial edge of the superior rectus, and the part beneath the superior rectus.

The first part of the fascial covering of the reflected tendon of the superior oblique is comprised of the medial expansion of the sheath of the levator muscle, the medial expansion of the sheath of the superior rectus muscle, and the extension of the fascia bulbi (fig. 13). The various membranes form a sheath two to three mm. thick about the tendon, so that the tendon and its sheath together are five to six mm. in diameter. Many delicate fibrillae surround the oblique tendon, attaching it to the adjacent fascial covering. This sheath completely encloses the trochlea, from which extensions can be seen to pass to the orbital septum in front, the muscle fibers of the superior oblique behind, and the periosteum adjacent to it.

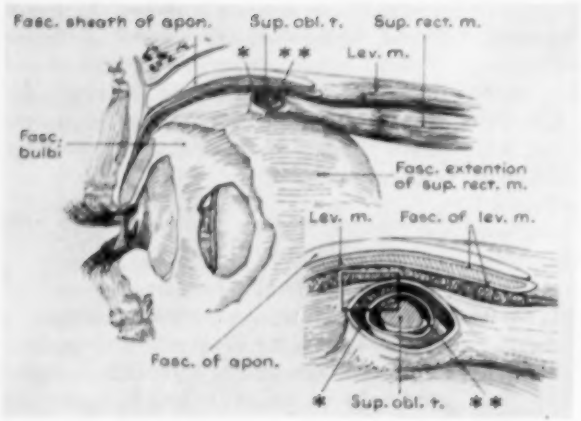


Fig. 13 (Fink). Fascial coverings of the superior oblique tendon. Sagittal section at the plane of insertion of the medial muscle. Fatty tissue has been removed so that only the fascial layers surround the oblique tendon. Trabeculae connect the tendon to the sheath immediately adjacent to it and also the adjacent fascial sheaths to each other (window in insert A). *Medial extension of the fascial covering of the superior rectus muscle blends with the condensation of the surrounding reticulum. **Extension of the fascia bulbi.

The second portion of the superior oblique tendon covering, which is beneath the superior rectus, has a somewhat less complicated arrangement. The oblique tendon in this area is covered by the fascia bulbi (fig. 14). Adjacent to the outer surface of the fascia bulbi is the fascial sheath of the superior rectus, to which it is normally loosely adherent. The undersurface of the fascia bulbi is in contact with the oblique tendon and the sclera. Arising from the undersurface of the fascia bulbi are many fibroelastic bands, or trabeculae, which form a union between it, the oblique tendon, and the sclera. The trabeculae in this region consist of broader bands of fibroelastic membrane rather than the tiny hairlike fibers found in the first portion above described; because of their structure, the movements of the globe are not restricted (fig. 15).

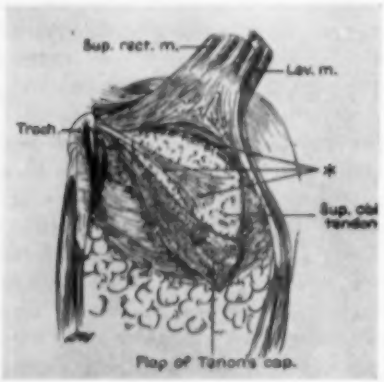


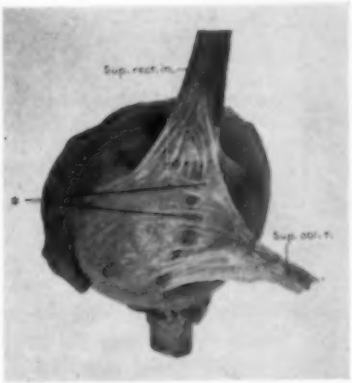
Fig. 14 (Fink). Relation of the fascia bulbi to the superior oblique tendon. Viewed from above. The fascia bulbi has been incised and a triangular flap reflected backward, showing the tendon of the superior oblique beneath.

Arising from the inferior surface of the fascia bulbi are many fibroelastic bands, or trabeculae, which form a union between it, the oblique tendon, and the sclera. *Cut ends of trabeculae which extend from the sclera to the fascia bulbi.

A study of a series of anatomic specimens show that there is some variation in the fascial formation in this region. The degree of fusion and fascial thickness varied where the fascial covering of the superior rectus and the fascial covering of the tendon of the superior oblique come in contact. Some were loosely adherent, whereas others were more firmly united. In this small series no marked fusion was evident, but some variation in degree existed. A variation in the trabeculae formation which immediately surrounded the oblique tendon was noted. A few specimens showed thicker, shorter trabeculae than were found in most of the specimens.

Embryologic considerations

The possibility of abnormal fascial formations in the region of the superior oblique insertion is more understandable when one



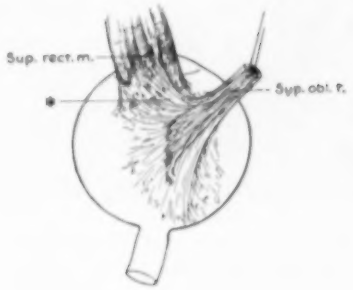


Fig. 15 (Fink). Trabeculae surrounding the fanned-out portion of the superior oblique tendon near its insertion. Viewed from above. The trabeculae in the fanned-out portion of the tendon are different in character from those in the more medial portion of the tendon. In the fanned-out portion, they are broad bandlike sheaths permitting considerable freedom of movement of the tendon, whereas more medially they are short, delicate fibers which permit only very limited independent movement. *Trabeculae which surround the insertion of the superior oblique tendon.

studies the early embryologic development of the area.

In the 40-mm. embryo the developing superior oblique can be traced to its insertion on the g'obe. At this stage the insertions of the superior rectus and superior oblique muscles are poorly defined although they seem to blend with each other and the surrounding mesoderm (fig. 16).

In the 75-mm. embryo the superior oblique and superior rectus insertions can be more accurately determined, and as in the 40-mm. embryo they lie in such close proximity that they seem to be fused to each other. Dense mesoderm surrounds and unites the two muscles near their point of insertion (fig. 17).

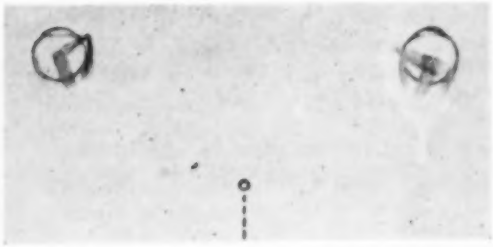


Fig. 16 (Fink). Drawing of a 40-mm. (two and one-half month) human specimen. In the 40-mm. embryo the developing superior oblique can be traced to its insertion on the globe. At this stage the insertions of the superior rectus and superior oblique muscles are poorly defined although they seem to blend with each other and the surrounding mesoderm. Circle shows actual size of the eyeball.

It is not until the embryo has reached the 260-mm. stage that a definite shift backward and separation of the superior oblique insertion can be noted. This shift backward is progressively more evident in the older embryos (fig. 18). Associated with this process is a gradual lessening in the density of the mesoderm which surrounds the two insertions and in the later stages of development appears as loose bands of fascial tissue which continue to connect the two muscles.

A study of these early embryonic stages impresses one with the possibility of anomalous formation. A failure of the superior oblique insertion to shift backward, such as occurs in lower mammals, would create variable mechanical problems. Also incomplete maturation of the dense mesoderm which surrounds the areas of insertion would tend to create a variable degree of abnormal fusion. This fusion could bind the adjacent structures firmly together, producing mechanical problems which might

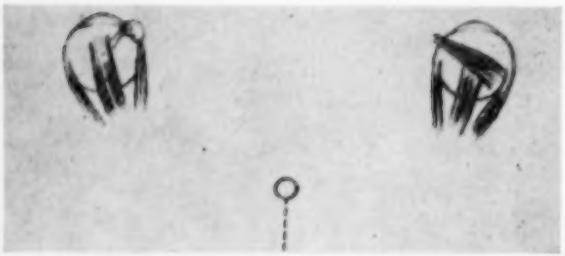


Fig. 17 (Fink). Drawing of a 75-mm. (three-month) human specimen. In the 75-mm. embryo the superior oblique and superior rectus insertions can be more accurately determined and like in the 40-mm. embryo lie in such close proximity that they seem to be fused to each other. Dense mesoderm surrounds and unites the two muscles near their points of insertion. Circle shows actual size of the eyeball.

affect the normal action of the muscles.

It is evident, therefore, from the study of the intricate early development of the area that anomalous development of the area is possible.

Clinical data

The fascial anomalies associated with the superior oblique as seen by me may be divided into two groups: Group 1 is comprised of anomalous fascial developments in the area of the superior oblique insertion; Group 2 contains anomalous changes associated with the sheath of the superior oblique tendon medial to the superior rectus.

Group 1. In this group, comprised of three cases in which the anomaly could be positively identified, the anomalous fascial formations do not differ greatly from those described above in the section dealing with fascial anomalies of the superior rectus. These cases in Group 1 showed abnormal changes predominantly in the vicinity of the oblique tendon, while those of the superior rectus showed abnormal changes chiefly in relation to the fascial coverings near the insertion of the superior rectus.

The anomalies of the superior oblique insertion consisted of abnormal thickening and fusion of the fascia bulbi adjacent to the fanned-out tendon of the superior oblique (fig. 19). The process appeared to be especially related to the fascia bulbi and trabeculae which immediately surround the oblique tendon. The trabeculae were shorter and thicker than normal and seemed to bind the tendon and its sheath to the underlying sclera.

The existence of the abnormal state was evident when an attempt was made to pull the oblique tendon forward into view. It was found to be adherent to the surrounding fascia and sclera, and only when the fusion was severed was it possible to manipulate it as in the normal case.

In all instances the fascial covering of the superior oblique (fascia bulbi) was thickened and firmly adherent to the fascial sheath of the superior rectus, but the adhesion was not as firm or as extensive as the adhesion described in relation to the anomaly of the superior rectus.

It was evident that such fascial formations

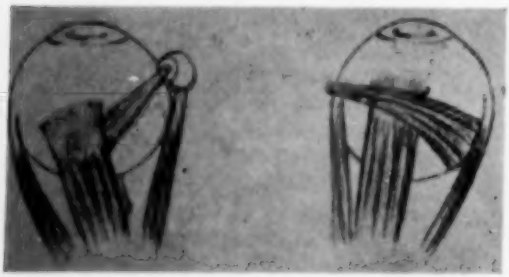


Fig. 18 (Fink). Drawing of a 260-mm. (five and one-third month) human specimen. It is not until the embryo has reached the 260-mm. stage that a definite shift backward and separation of the superior oblique insertion can be noted. This shift backward is progressively more evident in the older embryos. Associated with this process is a gradual lessening in the density of the mesoderm which surrounds the two insertions and in the later stages of development appears as loose bands of fascial tissue which continue to connect the two muscles.

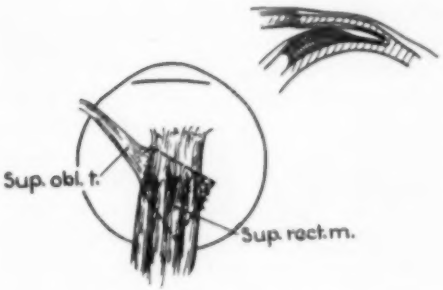


Fig. 19. (Fink). Drawing showing the location of anomalous formations in the region of the insertion of the superior oblique. The anomaly of the superior oblique insertion consists of abnormal thickening and fusion of the fascia adjacent to the fanned-out tendon of the superior oblique. The process appeared to be especially related to the trabeculae which surround the oblique tendon. The trabeculae were shorter and thicker than normal and seemed to restrict the movement of the oblique tendon.

restricted the action of the superior oblique and created a mechanical obstacle. Separation of such adhesions permitted a normal movement of a previously limited excursion of the globe in the field of action of the superior oblique.

Judging from my own experience, recognizable fascial anomalies in this region are unusual. Although the more pronounced cases could be identified, milder cases undoubtedly have gone unrecognized as such. Very likely a more critical examination based on wider experience with the normal structure would reveal a higher percentage of anomalous fascial changes in this region.

Johnson[3] described an anomaly in which there was adherence of the superior rectus to the superior oblique, with the superior oblique attached near the insertion of the superior rectus:

"Anyone who has looked carefully at the insertion of the superior oblique when it seemed to be paretic (at the time of a shortening or advancement operation) has noticed that there are times when the superior oblique comes up, remains attached and adherent to the superior rectus at this point and then runs backward to its insertion.

"This anomaly simulates paresis of the superior oblique with head tilting and is easily missed if the relation to the superior rectus is not examined prior to engaging the superior oblique tendon on the squint hook, for an area of disabling adherence may easily be separated in making the exposure.

"Instead of the superior oblique acting as the depressor, its insertion is up at the insertion of the superior rectus and, as a result, it cannot depress the eye. If anything, it would act to elevate the eye further. I am sure all of you who have separated those adhesions at this point, and have allowed the superior oblique to fall back so that its insertion can be normal, have found those patients have had normal depression without any shortening procedure on the muscle."

It seems important to me to stress the possibility of such an adhesion developing following excessive recession or resection of the superior rectus. Because of the close relationship of the superior oblique tendon to the insertion of the superior rectus, care should be exercised in surgery of the superior rectus to avoid such a possibility. An adhesion between the two muscles at this point could inhibit the action of both muscles and accentuate the binocular problem.

Group 2. The second type of fascial anomaly encountered involved the fascial sheath of the superior oblique tendon medial to the superior rectus (fig. 20). In these cases the sheath of the superior oblique was thickened and more inelastic than normal. The more rigid state of the sheath caused a restricted movement of the eye, not only upward and inward, but also downward and inward, although to a lesser degree.

Similar changes have been described by Brown,[20] who referred to them as the "superior oblique tendon sheath syndrome." Brown believes that normally the superior oblique sheath acts as a check ligament for

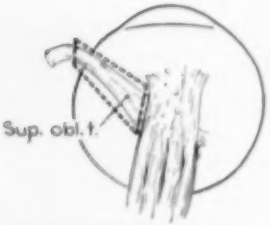


Fig. 20 (Fink). Drawing showing the location of anomalous formations of the fascial sheath of the superior oblique, medial to the superior rectus. The fascial anomaly encountered involved the fascial sheath of the superior oblique tendon medial to the superior rectus. In these cases the sheath of the superior oblique was thickened and more inelastic than normal.

the inferior oblique, and that the tendon sheath will, if short, restrict elevation in the nasal field. He considers this to be the developmental result of a congenital paralysis of the inferior oblique. He stated that the inferior oblique muscle seemed structurally normal, and its check ligament (the anterior sheath of the superior oblique) was congenitally short because of a lack of force during its development. He thinks that it is physiologically reasonable that the check ligaments undergo changes, that is, they become contracted by prolonged lack of force, thus restricting the movements.

In his case, he could demonstrate the congenitally short superior oblique tendon sheath. There was restricted elevation to forceps manipulation to below the horizontal plane, with the eye held in full adduction. After surgical separation of the superior oblique tendon from its sheath, a suture was placed around the sheath, and the sheath and tendon were dropped back into place. The tension on the sheath was then easily demonstrated by traction on the suture during forced elevation of the eye in the nasal field. After the sheath was cut transversely there was free passive movement of elevation.

In three cases of this type seen by me, in which an anomaly could be definitely identified, it impressed me that the disturbance was primarily a fascial malformation of the superior oblique sheath rather than secondary to the inferior oblique. This opinion was based upon the fact that the anomalous change was associated with a similar change in an adjacent structure. In one instance the abnormal state involved the medial rectus and its sheath with extension to the neighboring fascia, including the fascial sheath of the superior oblique tendon. In the other cases the fascial anomaly of the oblique sheath was associated with a similar process involving the sheath of the superior rectus.

Such an anomaly of the fascial sheath of the superior oblique has a restricting influence on the rotation of the globe. This was demonstrated in the above cases, because a fuller rotation of the globe was possible when the abnormal fascial membranes surrounding the oblique tendon medial to the rectus muscle were severed.

One may speculate that when there is a moderate degree of involvement, this may be the cause of some of the less pronounced cases of mechanical disturbance related to the superior oblique.

Fascial anomalies associated with the inferior oblique

In the case of the inferior oblique we have more evidence of abnormal fascial formation, both in the dissecting room and at surgery.

Anatomic considerations

A fascial membrane encloses the inferior oblique from its periosteal origin to its insertion. The expansions of this sheath extend anteriorly and posteriorly to blend with the adjacent fascia. There is thus formed a continuous band of fascial membrane about one-tenth of an inch thick, beneath the globe, supporting it like a hammock; it is usually referred to as the suspensory ligament of Lockwood.

Two important modifications of the fascial membrane related to the inferior oblique muscle are of interest: (1) the modification of the fascia at the point of crossing of the two muscles; (2) the modification of the

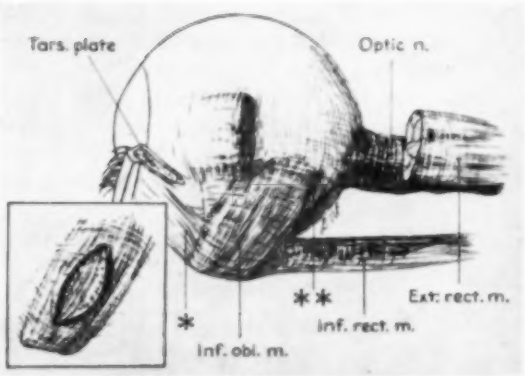


Fig. 21 (Fink). Relation of the sheath of the inferior oblique muscle to the adjacent structures. Lateral view. The membranous sheath covering the inferior oblique muscle extends anteriorly and fuses with the sheath of the lateral rectus muscle. Posteriorly it fuses with the fascia surrounding the optic nerve. *Fascial sheath extending forward to the orbital septum and acting as a check ligament to the inferior oblique muscle. **Posterior extension of the sheath of the inferior oblique muscle fusing with the sheath of the optic nerve.

fascia which serves as a sheath to the inferior oblique muscle near the point of insertion.

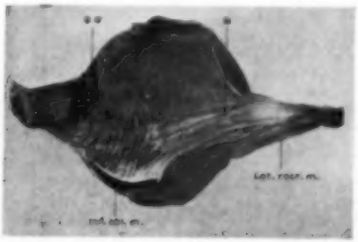
1. The most important modification of the fascial sheath is found at the point of crossing of the inferior rectus and the inferior oblique muscles. This has been described above in the section dealing with the anatomy of the inferior rectus.

2. The second anatomic consideration of the fascial sheath is the modification which occurs as it approaches the insertion of the inferior oblique (fig. 21). Near the insertion, the muscle sheath fans out anteriorly to fuse with the lateral rectus muscle sheath and posteriorly to fuse with the fascial sheath surrounding the optic nerve (fig. 22). These fascial expansions of the sheath near the insertion vary in degree of development and the degree of fusion with the adjacent structure. An accentuation of these processes could conceivably create a mechanical obstacle.

Embryologic considerations

Embryologic study of the area of insertion of the inferior oblique stresses the possibility of anomalous development in this area.

In the early embryonic stages, as seen in the 40- and 75-mm. embryos, the inferior oblique insertion is in close contact with the insertion of the lateral rectus. At this stage the mesoderm covering forms a dense mem-



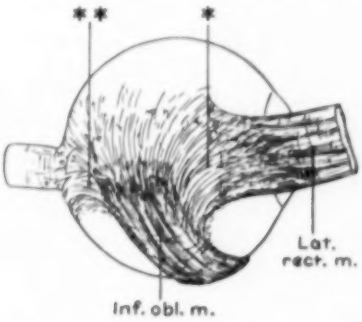


Fig. 22 (Fink). Fascial arrangement at the insertion of the inferior oblique muscle. Lateral view. Near the insertion of the inferior oblique muscle, the muscle sheath fans out anteriorly to fuse with the sheath of the lateral rectus muscle and posteriorly to fuse with the fascial sheath surrounding the optic nerve. *Fanned-out portion of the fascial sheath of the inferior oblique muscle fusing with the fascial sheath of the lateral rectus muscle. **Fanned-out portion of the fascial sheath of the inferior oblique muscle fusing with the fascial sheath of the optic nerve.

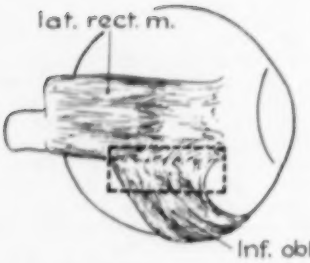


Fig. 23 (Fink). Drawing showing the location of anomalous formations in the region of the insertion of the inferior oblique. The anomaly consisted of a firm fusion between the sheath of the lateral rectus and the sheath of the inferior oblique at the point where the inferior oblique comes in contact with the lateral rectus. This varied in degree —some showed a mild change; in others, where a firm fusion existed, the process was pronounced.

brane around the insertion of the two muscles causing them to be firmly fused (figs. 16 and 17).

Following these early stages the insertion of the inferior oblique is found to be separated from the insertion of the lateral rectus. In successive stages of development it is found to shift posteriorly until it reaches its final point of insertion (fig. 18). During this period the mesodermal covering of the insertions progressively lessens in density and the degree of fusion between the two insertions lessens until in the adult stage only loose fascial extensions normally unite the two muscles.

The study of these early specimens emphasizes the possibility of anomalous development both in the oblique insertion and its fascial structure. A retardation of or deviation in development can create an abnormal insertion or fusion and thickening of the fascia which could cause mechanical problems in the function of these muscles.

Clinical data

In my experience two types of anomalous developments have been observed near the insertion of the inferior oblique.

The first type relates to the fusion between the sheath of the lateral rectus and the sheath of the inferior oblique at the point where the inferior oblique comes in contact with the lateral rectus.

The blending of the sheath of the lateral rectus with the sheath of the inferior oblique is normally physiologically loose. While this loose union is definite enough, there is not sufficient adherence to limit rotation.

In is not unusual to find a firmer union between the two muscles because of an increased fascial development and fusion between the two (fig. 23). This varies in degree; in some cases there was a mild change, while in others the process was pronounced and a firm fusion existed. The degree of restriction in movement is in proportion to the amount of abnormal development and fusion. Severing of this fusion permitted normal rotation of the globe.

Johnson,[3] in discussing such fusion and its effects, states that anomalous development results in the adherence of the sheaths of the lateral rectus and inferior oblique muscles. His experience indicates that adherence of the lateral rectus to the inferior oblique muscle is seen as an etiologic factor in the production of strabismus which simulates bilateral rectus paralysis. In the adherence of the two muscles, rotation is limited because the functional attachment of the lateral rectus becomes that attachment of the inferior oblique which is so far posterior that even powerful efforts at lateral rotation could not rotate externally, but could only retract, the temporal aspect of the globe.

Johnson found that the first reason for suspecting that there is adherence of the lateral rectus and inferior oblique sheaths is the clinical appearance of paresis of the lateral rectus. If external rotation is limited, there may be true paresis or there may be adherence, and the "fixed muscle" duction test must be employed for further understanding.

Anderson[22] states that in his experience the commonest fascial changes from normal which are related to the vertical muscles are

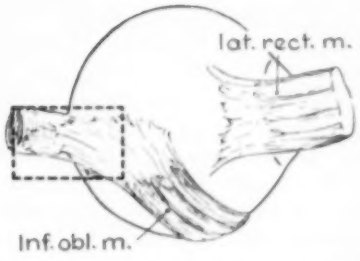


Fig. 24 (Fink). Drawing showing the location of anomalous formations in the region of the insertion of the inferior oblique. The abnormal fascial development in this instance relates to the posterior expansion of the sheath of the inferior oblique near its insertion where it fuses with the sheath of the optic nerve. In this anomaly there was a thickened inelastic development of the posterior expansion of the inferior oblique sheath.

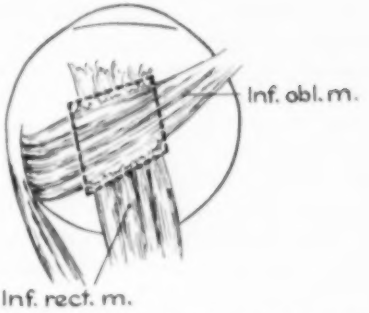


Fig. 25 (Fink). Drawing showing the location of the fascial fusion at the point of crossing of the inferior rectus and the inferior oblique muscles.

inferior oblique attachments. "The attachment of sheaths of the inferior oblique and the external rectus shows great variation which is strange when one thinks of their comparatively old association. There are probably just as many variations in the superior oblique attachments."

The second type of abnormal fascial development in this region relates to the posterior expansion of the sheath of the inferior oblique near its insertion and fusion with the sheath of the optic nerve (fig. 24).

In this anomaly there is a thickened, inelastic development of the posterior expansion of the inferior oblique sheath. When the abnormal fascial expansion is severed a normal action of the muscle is possible. Such an anomaly is not rare and is important to recognize, because unless it is severed the result of a recession operation may be nullified.

One cannot leave the subject of fascial anomalies of the inferior oblique without some mention of the possible significance of a firm fusion at the point of crossing of the inferior oblique and inferior rectus muscles (fig. 25).

As mentioned previously, the degree of fusion between the fascial sheaths of the two muscles is variable. In the anatomic material examined by me some specimens showed a very firm union, even a complete fusion of the fascial sheaths. Others showed a very loose fusion, there being but a few bands of fibrous tissue connecting the two fascial muscles sheaths, which could be separated with ease. Between these two extremes there was a group of specimens in which the union between the sheaths was moderate. In those showing a firm union, there seemed to be no independent movement of the two muscles, which gave the impression of being a solidly fused structure. In those having a loose fusion, the independent movement of the two muscles was very definite.

At present, we have no definite evidence which would indicate the significance of such a fusion. However, it is my opinion that it is important. One can speculate that an abnormally firm fusion at this point could not only affect the action of the inferior oblique, it could also restrict the action of the inferior rectus. Some of our poor operative results on these muscles may have such a basis. In such cases a separation of this fusion may be indicated, but as yet our knowledge of this problem is too limited to justify the step.

Conclusion

The clinical significance of vertical anomalies has as yet not been determined.

Although our concept concerning horizontal anomalies is fairly well developed, infor-

mation relating to vertical anomalies is comparatively meager. This is understandable when one considers that operations on vertical muscles are relatively infrequent, and that the field of operation is limited so that the structures are not sufficiently exposed for accurate inspection. Lack of familiarity with the complex anatomy of the area makes comparison with the normal difficult, especially when the deviation is mild in degree.

With the hope of establishing a more definite basis for an opinion concerning the role of anomalous development in vertical defects this presentation has attempted to assemble some tangible evidence pertaining to anomalous developments of the vertical mechanism and to evaluate their role as a mechanical obstacle to binocularity.

An analysis of available data indicates that vertical anomalies do occur. They tend to occur in certain areas, and they create mechanical obstacles in proportion to their degree. Our knowledge concerning vertical anomalies is too incomplete to attempt an opinion concerning the frequency of their occurrence. The more complex anatomy of the vertical region suggests the possibility that more anomalies may occur there than may occur in the horizontal region.

It is not merely of academic interest but of practical importance to recognize a vertical anomalous formation. Our present-day approach to the vertical problem is handicapped because of the obscure etiologic basis. It is usually possible to determine that the underaction of an ocular muscle is due to a mechanical defect, but whether or not it is anomalous is difficult to determine. It is important in the management of such a case to make a positive determination if possible, because it may influence the procedure. The surgical handling of an anomalous state may be far different from that of a paresis of the muscle. The value of exact diagnosis is apparent when one realizes that the mere separation of an anomalous adhesion may correct the muscle defect and thus prevent the multilation of a normal muscle.

It is hoped that this presentation will serve to stimulate further interest in the subject of vertical anomalies so that an opinion based on more complete data can be arrived at. That such an opinion is important seems evident when one considers the important role vertical defects play in ocular imbalance.

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ANTIBIOTIC AND CHEMOTHERAPEUTIC AGENTS IN TREATMENT OF TRACHOMA*

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Due to the wide prevalence in India, of blindness resulting from trachoma, a search for an effective therapeutic agent is constantly going on. It is now almost certain that, trachoma is a virus disease. Several workers have even demonstrated the presence of trachoma virus in the follicles by electronic microscopic examination. The trachoma virus is said to be allied to Rickettsia bodies. The presence of inclusion bodies in follicles has been indirect evidence of its viral origin. Agarwal and Gupta (1954) used the presence of inclusion bodies to control the therapeutic regimen. In the present study the effectiveness of terramycin, chloramphenicol, aureomycin, erythromycin, Irgafen and Sulfacetamide has been compared.

Earlier work

Terramycin

Mitsui and Tanaka (1951) have reported beneficial results on this therapy. The report has received support from Mitsui, et al. (1951) after a survey of 700 cases of trachoma. There are several other workers who share this optimism. Agarwal and Gupta (1954) feel that the drug is of limited value. Leopold (1951) and Siniscal (1952), however, do not think it of much value in trachoma except to help clear secondary infections.

Chloramphenicol

Magnol (1950) was enthusiastic about the use of chloramphenicol in trachoma. His views were supported by Pijoan, et al. (1950) and Payne, et al. (1949). Magnol feels that both local and oral therapy is indicated and claims as high as 90 percent cures. Agarwal and Gupta, while considering this drug effective in a small percentage of cases do not share the optimism of other workers. Leopold and Siniscal consider the drug of doubtful value.

Aureomycin

Quite a large number of workers, among them Braley and Sanders (1949), feel that aureomycin is the treatment of choice. More recently Ngo-Van-Hieu (1951) considers that the drug effects almost a complete healing in the first three stages. Their findings were supported by Boase (1950), who reported complete and rapid disappearance of pannus, and Rais and Arroyo (1950), who reported similar results. Trope (1951) from South Africa was equally enthusiastic about this form of treatment. Agarwal and Gupta contend that the drug is quite effective in the treatment of trachoma, as evidenced by retrogressin of pannus and disappearance of inclusion bodies, but the results are not uniform. Shah (1951), Nataf (1950), and Ching (1951) recommend this form of therapy for the relief of subjective symptoms. Leopold and Siniscal were not impressed with aureomycin.

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Erythromycin

This drug is supposed to be active against Rickettsia. Agarwal and Saxena (1954, in press) are of the opinion that it is a quick acting drug and results in a cure in about 50 percent of trachomatous cases.

Sulfonamides

Varied opinions have been expressed regarding the efficacy of sulfonamides in the treatment of trachoma. Thygeson (1940), Luo and Chang (1940), Sorsby (1945) and a large number of other workers have a feeling that the sulfonamides only help to clear secondary infection. There are an equally large number who think that sulfonamides have a direct antiviral effect and strongly advocate their use. Large numbers of sulfonamide preparations have been used. Lavery (1946) strongly advocated their use. More recent support has been given by Siniscal and Agarwal and Gupta who consider them to be the best form of therapy.

Methods and Material

A series of 400 cases of trachoma with inclusion bodies demonstrated by the staining method of Poleff (1952) were selected for this study. The cases were either in the infiltrative or the follicular stage.

Conjunctival scrapings were obtained from the upper fornix by a sharp curette for the purpose of examination of the inclusion bodies. The scrapings were repeated at two- to three-week intervals.

Fifty cases were treated as controls with no treatment except normal saline.

Sixty cases were given terramycin drops in each eye (2.5 mg./cc.) three times in a day. Terramycin ointment (0.1 percent) at bed time was applied for six weeks. They were also given four capsules a day for a week.

Sixty cases were given chloramphenicol drops in the concentration of 2.5 mg./cc. three times daily, ointment (one percent) at bed time for six weeks, and oral administration of capsules (four capsules a day for a week) was also resorted to.

Sixty cases were treated by aureomycin ointment (one percent) three times daily for six weeks, and four aureomycin capsules a day for a week.

Fifty-five cases were treated by erythromycin ointment (one percent) twice daily. The patients were also given 42 tablets orally spread over two weeks.

Seventy cases were given sulfacetamide (Lŏcula, 30 percent) one drop three times in a day and sulfacetamide ointment (Lŏcula, 10 percent) one daily for six weeks. Sulfacetamide tablets, two tablets three times daily for four days [Sulfocid] and then one tablet three times daily for 10 days were also given.

Forty-five cases were treated with Irgafen (di-methyl-benzoyl-sulfanilamide) as drops (10 percent) one drop three times daily, and Irgafen ointment (15 percent) once daily for six weeks. They were also given oral tablets, one tablet a day for two weeks.

Search for inclusion bodies was made every two to three weeks and the treatment was continued for six weeks irrespective of the presence or absence of inclusion bodies. The effect of the drugs on the pannus, secondary infection, and subjective symptoms was also noted.

Observations

Untreated cases

Inclusion bodies were present in all the specimens of the tissue scrapings in almost all cases. It was concluded, therefore, that the inclusion bodies do not disappear from the tissue scrapings until and unless some therapeutic measures are adopted. The subjective symptoms or pannus also did not show any abatement, leading us to conclude that mere scraping does not form a therapeutic procedure.

Terramycin

The results obtained indicate that there is

a complete clearance of secondary infection in 48 to 72 hours and considerable relief in subjective symptoms. Only 14 cases out of 60 showed a regression in pannus and disappearance of inclusion bodies.

Chloramphenicol

The results as far as secondary infection and subjective symptoms were concerned were identical to those with terramycin. A greater percentage of cases (19 out of 60) showed retrogression of pannus and disappearance of inclusion bodies.

Aureomycin

This therapy gave a response similar to terramycin and chloramphenicol as far as secondary infection and subjective symptoms were concerned but the drug proved to be more effective in curing this disease (24 out of 60).

Erythromycin

Like other antibiotics this drug also cleared secondary infections within 48 to 72 hours and relieved subjective symptoms. The rate of cure was better than with the other antibiotics (28 out of 55), though less efficacious than sulfonamides. The drug seems to have a quicker action than other antibiotics.

Sulfacetamide

The secondary infections and subjective symptoms were relieved completely within 48 hours by this therapy. A very large percentage of cases showed retrogression of pannus and disappearance of inclusion bodies from tissue scrapings (51 out of 70). Compared to other drugs the action is a little slower but the drug is more effective.

Irgafen

The results obtained with Irgafen were identical to those with sulfacetamide (32 out of 45 were cured). The results are summarized in Table 1.

Discussion

The criterion of cure in this series was the absence of inclusion bodies and retrogression of pannus. Reports in the literature regarding the efficacy of antibiotic and chemotherapeutic agents in the treatment of trachoma show conflicting opinions.

Pijoan, et al. Payne, and Magnol claim good results with chloramphenicol, while Leopold and Siniscal consider it ineffective. Agarwal and Gupta feel that the drug is of limited value though effective in a small percentage of cases.

In a few cases terramycin has been found effective in combined oral and local therapy but the optimism of Mitsui and co-workers cannot be shared.

Ching, Dunphy (1950), and Shah feel

TABLE 1

SUMMARY OF RESULTS WITH VARIOUS FORMS OF TREATMENT IN TRACHOMA

Drugs	Cases Treated	Secondary Infection	Disappearance of				Total Cured (Percent)
			Pannus		Inclusions		
			3 Weeks	6 Weeks	3 Weeks	6 Weeks	
Terramycin	60	Within 48 to 72 Hours	9	6	7	7	23.3
Chloramphenicol	60		12	17	6	13	31.6
Aureomycin	60		14	15	12	12	0.0
Erythromycin	55		13	14	15	13	51.0
Irgafen	45		14	20	12	20	71.0
Sulfacetamide	70		17	36	20	31	72.6

that aureomycin has no effect on the trachoma virus itself while there are many others who are very optimistic about its antiviral effect. We think that the drug has limited value and that the criticism that it has no antiviral effect is unjustified in view of retrogression of pannus and disappearance of inclusion bodies.

Agarwal and Saxena believe that erythromycin is effective against trachoma and we are in complete agreement with their findings.

Sulfacetamide has been said to be quite an efficacious drug in the treatment of trachoma. No doubt it is the drug of choice and in this we are in complete agreement with Siniscal, Lavery, and Agarwal and Gupta. Irgafen seems to be equally effective.

Because opinion is so diversified regarding the various therapeutic agents we think that either the sensitivity of the trachoma virus is not uniform or there is more than one strain of the virus. A perusal of the literature shows a marked geographic variation in the responses to various drugs which points to the possibility that more than one strain of trachoma virus exists.

Summary

1. Four hundred cases of trachoma have been studied.

2. The presence of inclusion bodies was determined at two- to three-weeks intervals.

3. Terramycin, chloramphenicol, aureomycin, erythromycin, Irgafen and sulfacetamide are all effective against the trachoma virus.

4. All the drugs used in this series relieved subjective symptoms and cleared secondary infection.

5. Among the antibiotics, erythromycin was the most and terramycin the least efficacious.

6. Sulfacetamide and Irgafen are most efficacious in the treatment of trachoma and a combined local and oral therapy of these is recommended.

Acknowledgements

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THE SECOND EYE IN ACUTE, PRIMARY, SHALLOW-CHAMBER ANGLE GLAUCOMA*

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INTRODUCTION

It is generally stated that the second eye is especially susceptible to an acute attack of primary, shallow-chamber angle glaucoma following such an attack in the first eye. However, there is a surprising lack of specific information on the frequency of attack in the second eye, and the effectiveness of preventive treatment. Consequently the care of the second eye tends to be empirical and poorly organized, and definitive treatment is often neglected.

In this paper the fate of the second eye has been studied in 47 cases of acute congestive, shallow-chamber angle glaucoma where the second eye was normal at the time of the initial attack in the first eye. With due regard to the sources of error inherent in a survey of this type, the findings provide information with which a clinician might answer such questions as:

1. What proportion of patients get an attack in the second eye?
2. How long a time might be expected to pass before such an attack is likely to occur?
3. Does age increase the susceptibility to attack in the second eye?
4. Can an attack in the second eye be prevented by miotics or prophylactic iridotomy?

MATERIALS AND METHODS

Approximately 1,000 histories of glaucoma patients seen at the Wilmer Institute, The Johns Hopkins Hospital, between the years 1939 and 1949 were examined. Out of this group 47 well-documented cases were found for this study. Only primary shallow-chamber angle glaucoma was included; all cases of secondary, shallow-chamber angle glaucoma, from whatever cause, were excluded.

The criteria for inclusion of a case were:

1. An acute congestive attack in the first eye with initial tension over 60 mm. Hg (Schiøtz).
2. A specific notation in the chart that the anterior chamber angle was shallow in each eye, either by slitlamp or gonioscopic examination.
3. Tension in the second eye normal at the time of the first admission and no history of previous attack in that eye.

RESULT

Of the 47 cases included in the study an acute congestive attack occurred in the second eye in 32 (68 percent).

The time interval between the attack in the first eye and that in the second eye varied from a minimum of a few hours to a maximum of 18 years. In 29 cases (62 percent) the attack in the second eye occurred within five years of that in the first eye. The age of the patient did not appear to influence the susceptibility of the second eye to an attack of acute congestive glaucoma. Once an attack had occurred in the first eye, the patients were equally susceptible to an attack in the second eye at all ages.

The influence of miotics was as follows (table 1):

TABLE 1

EFFECT OF PROPHYLACTIC MIOTICS ON THE SECOND EYE IN ACUTE CONGESTIVE, PRIMARY, SHALLOW-CHAMBER ANGLE GLAUCOMA

Miotics	Number of Cases	Number Having Attack in Second Eye	%
Continuous	20	8	40
Intermittent	8	7	88
None	19	17	89

* From The Wilmer Institute, The Johns Hopkins Hospital, Baltimore, Maryland.

In 20 cases miotics were used continuously in the second eye as a prophylactic measure. In this group eight patients suffered an acute congestive attack in the second eye in spite of miotics (40 percent). Eight patients took miotics only intermittently and in seven of these (88 percent) an attack occurred in the second eye. Nineteen patients took no miotics whatsoever, and 17 of these (89 percent) suffered an attack in the second eye. Considering these latter two groups together 27 patients took miotics intermittently or not at all of whom 89 percent suffered an attack in the second eye.

In recent years a prophylactic iridotomy has been performed on the second eye in six cases, but the follow-up is as yet insufficient to compare the effectiveness of this procedure with that of prophylactic miotic therapy.

Discussion

Eighty-nine percent of 27 patients who received no prophylactic treatment or who took miotics only intermittently had an acute attack in the second eye at some time after the initial attack in the first eye. This incidence is comparable to that reported by Goldberg[1] and supports the general statement of textbooks and monographs that the second eye is especially prone to acute attack in primary, shallow-chamber angle glaucoma.

In 20 patients who took miotics continuously 40 percent had an acute attack in the second eye. This is less than half the frequency found in the poorly treated group but still leaves a large proportion of cases subject to attack in the second eye.

In recent years some authorities have advocated prophylactic iridotomy as a more effective preventive measure in the normal second eye. Chandler[2] now advises "prophylactic peripheral iridotomy for the fellow eye for all young and middle-aged patients wth acute glaucoma." Scheie[3] recommends surgery for the second eye without waiting for an acute attack in this eye.

Some estimate of the time interval to be expected between the attack in the first eye and that in the second eye is gained by finding in this study that the attack rate in the second eye was 62 percent in five years. This suggests that prophylactic iridotomy is especially indicated in the younger patients suffering an acute attack in the first eye.

Summary

1. Eighty-nine percent of 27 patients who took miotics intermittently or not at all suffered an attack of acute shallow-chamber angle glaucoma in the second eye.

2. Forty percent of 20 patients who took miotics continuously had an attack in the second eye.

3. Sixty-two percent of the attacks in the second eye occurred within five years of the first attack in the first eye.

4. Preventive treatment of the sound second eye in acute congestive, shallow chamber angle glaucoma should include either continuous miotics or prophylactic peripheral iridotomy.

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HIOKI'S POLARIZATION ANOMALOSCOPE

I. Technical study

Ryuichi Hioki*

and

II. Clinical study

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Introduction

The examination of color vision serves to classify congenital defective color vision, to aid color-blind persons to select the proper professions, and to study the nature of acquired color blindness in order to diagnose those diseases in which it occurs.

There are two methods of examination: One is Ishihara's test with his test chart which uses reflected light and is easy and convenient in practice; the other is Nagel's test with the anomaloscope which makes use of a dispersed spectrum and is very accurate in estimating the degree of color blindness.

Efforts to advance the examination of color vision seem to have been directed toward the improvement of Ishihara's method using reflected light in an attempt to make its degree of accuracy approach as near as possible that of the anomaloscope. Wölfflin's *Tafeln mit Umschlagfarben* detects a slight degree of defective color vision. Recently, in Japan, Dr. Okuma has designed a test chart for slight color blindness based on Ishihara's test chart.

Since in daily life, we are surrounded almost solely by reflected light, the examination of color vision with the test chart using reflected light seems to be the most natural and practical method and it is easy to carry out. So we depend largely upon improvement of this method. However, as the reflected light consists of many rays of different wavelength, it is extremely difficult to determine the constituent parts quantitatively, even if the main wavelength can be determined. For this reason, the method using dispersed spectrum light, for instance Nagel's anomaloscope, types I and II, is preferable, if we are to determine accurately the degree of defective color vision or its kind.

Nagel's anomaloscope, the most accurate instrument so far contrived for examining color vision, is based upon an excellent principle but it poses some difficulty in color-match setting which have never been improved since the type II appeared. To correct this, a new type of anomaloscope has been devised by Hioki for trial in Japan.

Principle of Nagel's anomaloscope

The optical system of Nagel's anomaloscope consists essentially of a direct vision spectroscope in which two halves of a viewing field are illuminated respectively by a beam of monochromatic yellow light (sodium line) and an added mixture of monochromatic red (lithium line) and green (thalium line) light. The amount of the yellow light can be controlled by varying the width of the yellow slit, while the relative amounts of red and green light can be adjusted by varying the width of red and green slits simultaneously.

In persons with normal color vision the relative amounts of red and green light in the mixture, which are to cause the same perception as yellow light, are almost constant, whereas in those with defective color

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vision they are different according to the degree of deficiency. By measuring them we can describe quantitatively the kind and the degree of defective color vision.

In Nagel's anomaloscope, circular scales are attached to the controlling screws of the "yellow" slit and the "red" and "green" slits, from the scale readings of which at the color matching a diagnosis can be made. In the improved type II an ocular tube has been devised to rotate horizontally so that the wavelength of color-matched light can be varied within a visible spectral range.

Improvement of Nagel's anomaloscope

While the study of defective color vision has made great progress by improving isochromatic charts, the method using dispersed spectrum light has remained stationary. Only Hegner has designed a chromotester in which color matching is by a single colored light (instead of a spectrum light) as in the anomaloscope; William, Vhonson, Donders, Edridge, and Green and others devised the lantern test.

In Nagel's anomaloscope, type II, the mixing wavelength of Thallium green (535 mμ.) was altered to the longer wavelength (544 mμ.) by Kohlrausch.

Construction of Hioki's anomaloscope

This instrument (fig. 1) is an improved type of Nagel's anomaloscope. It is especially intended to make the color-match settings more simple. It consists of a lamp house and a main body to which is attached a voltmeter and a voltage regulator to adjust the power source.

The internal construction is: three entrance slits are placed horizontally in the focal plane of the first collimating lens, as illustrated in Figure 2. One of them is the "yellow" slit and the other two are the "red" and "green" slits as in Nagel's anomaloscope. These slits are illuminated uniformly by the light source.

Behind the "yellow" slit which is on the left-half side there is a neutral optical wedge, the displacement of which varies the intensity of light. And behind the two "red" and "green" slits on the right half there are fixed two polarizers so that light passing through them turns into polarized light with mutually perpendicular polarizing planes. The parallel beam from the collimator lens is refracted through the direct vision prism and is then incident on the biprism. Further, the light beam enters into the observer's eye after being traversed through the second lens, the analyser, and the exit slit which is placed in the focal plane of the second lens.

The angle of rotation of the analyser can be read on the gradation scale. It can be rotated completely or to minute degrees. The neutral optical wedge can be moved with the handle and its amount of displacement can be read on the scale. The rotating prism is used to vary the wavelength of light within the visible range, and the angle of its rotation can be read on the scale.

Principle of Hioki's anomaloscope

A tungsten incandescent lamp of 250 watts and of color temperature of 3000°K. is used as the light source. An image of the lamp is focused by a condenser lens on to the direct-vision prism. The entire surface of the entrance slits is illuminated uniformly.

Each light beam from the entrance slits is dispersed and forms a continuous spectrum, respectively, in the focal plane of the

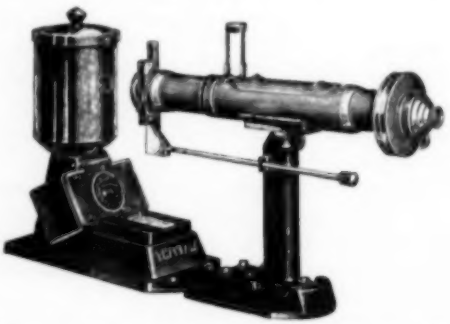

Fig. 1 (Hioki and Nakamura). The polarization anomaloscope.

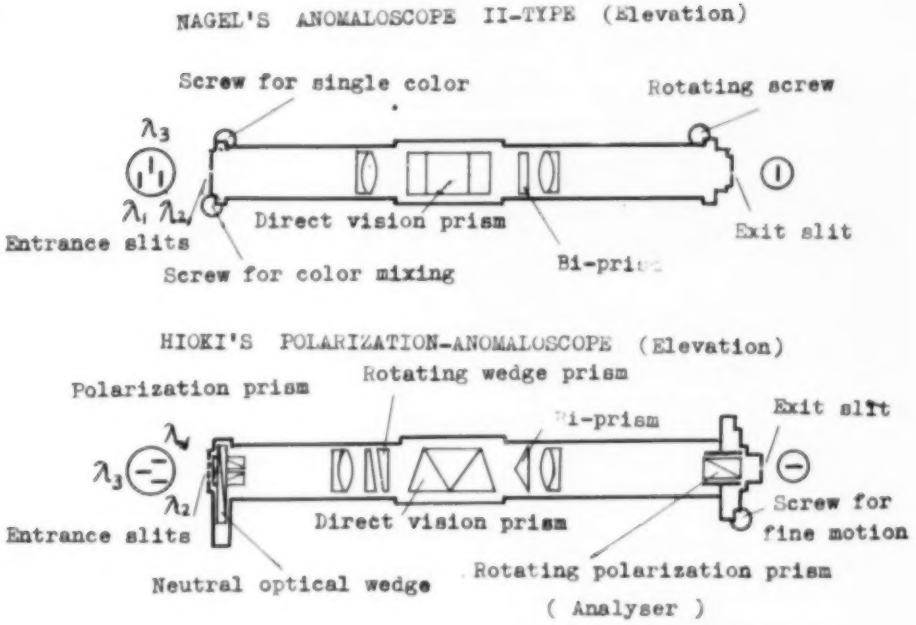

Fig. 2 (Hioki and Nakamura). Internal construction of polarization anomaloscope.

second lens. But the biprism divides the beam into two directions, one of which, to form a spectrum on-axis in the focal plane, is allowed to pass through the exit slit; while the other is to form another spectrum off-axis in the focal plane. Therefore, on the exit slit, may be produced the superposed spectra which consist of the two spectra corresponding to the "red" and "green" slits (right side) and one corresponding to the "yellow" slit (left side).

When the surface of the biprism is viewed with the Maxwellian view through the exit slit on the axis, the two halves of field (separated vertically) are illuminated by the different-colored light, the wavelengths of which are determined by the lateral position of the continuous spectra relative to the exit slit. The lateral position of the spectra is altered by the aid of the rotating wedge prism. Therefore, the spectra produced in the focal plane of the second lens are moved up and down and the wavelengths of light, λ_1, λ_2, and λ_3 corresponding to the three entrance slits, are varied simultaneously within a certain spectral range—the left half of the field is illuminated by the colored light due to the additive mixture of light of wavelength, λ_1 and λ_2, corresponding to the "red" and "green" slits at the right side, and the right half by the colored light of wavelength, λ_3, corresponding to the "yellow" slit at the left side.

Since the light beams of wavelength λ_1 and λ_2, are mutually perpendicular plane polarized light, the relative amounts of light of wavelengths, λ_1 and λ_2, can be altered by rotating the analyser. So when the wavelengths, λ_1, λ_2, and λ_3, are taken properly, then the color matching of the mixed light of wavelength, λ_1 and λ_2, against the light of wavelength, λ_3, can be obtained. In the color matching the difference in brightness is controlled with the operation of the neutral optical wedge.

Such a matching being found, the relative

TABLE 1

COMPARISON OF HIOKI'S ANOMALOSCOPE WITH NAGEL'S

	Nagel's Anomaloscope	Hioki's Anomaloscope
Variation of mixing ratio	Is made by changing the width of the entrance slit with the screw for color-mixing on the left side. The purity of color is changed	Is made by rotating the analyser. The purity can be kept constant since the widths of the entrance slits are unaltered
Variation of single colored light	Is made by changing the width of the entrance slit with the screw for single-colored light on the right side. The purity of color is changed	Is made by moving the neutral optical wedge behind the slit without changing the width of the entrance slit. The purity can be kept contant
Variation of the wavelength of single colored and mixed colored light	Is made by rotating the ocular tube horizontally with the screw for rotating to get the small hole of the tube to a certain position of the fixed spectrum	Is made by rotating the two rotation wedge prisms around the optical axis, thus causing the spectrum to move up and down
Size of the exit slit	A small rectangle 0.6-mm. wide	The same
Viewing field	1°15′, 2°10′, 3°12′	The same
Wave length of direct vision	486.1 mμ	The same

amounts of light of the wavelength, λ_1 and λ_2, can be exactly obtained from the scale readings of the analyser and of the neutral optical wedge, when the constants of the instrument (for example, spectral transmittance of the instrument due to polarized light) are already known.

These relative amounts of light can be regarded as the quantitative specification of defective color vision even if the constants of the instrument are unknown.

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OPHTHALMIC MINIATURE

The vitreous-humour is covered by a very fine membrane which is composed of two lamina. At the cavity or socket of the vitreous-humour, in which the crystalin-lens is lodged, those lamina separate; the internal covering (both) the cavity of the vitreous-humor and posterior convexity of the crystalin-lens; whilst the external lamen surrounds the anterior part of this body. By which mechanism the crystalin is firmly attached to the vitreous-humor.

A New Treatise on the Glaucoma, or Cataract,
By Silvester O' Halloran, of Limerick.
Printed by S. Powell, Dublin, 1749.

NOTES, CASES, INSTRUMENTS

A NEW AIR CONDITIONER*

FOR THE PATIENT DURING SURGERY UNDER LOCAL ANESTHESIA

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For a long time when using local anesthesia, we have been aware of the discomfort suffered by elderly patients while under drapes for eye surgery. The combination of accumulating excessive heat, increasing humidity, and carbon dioxide, together with an oxygen shortage, make elderly patients most uncomfortable, especially when they are lying flat on their backs. On two occasions, patients pulled the drapes away, complaining of a choking sensation.

Because of this, we had an air-conditioning expert devise a special blower that is safe, effective, and inexpensive (figs. 1 and 2). Its features consist of: (1) A continuous duty shaded pole motor; (2) positive-type squirrel-cage blower, delivering up to 50 cubic feet of air per minute; (3) filters are supplied and easily replaced (sterile gauze pads may be used); (4) the force and velocity of the air current may be cut by using more filters; (5) blowers are available in various voltages, to suit application; (6) motor is explosion proof; (7) quiet and noiseless operation; (8) long life; (9) inexpensive (price about $39.50 for entire unit); (10) small, compact, and completely portable.

Fig. 1 (Rosner and Gans). The air conditioner.

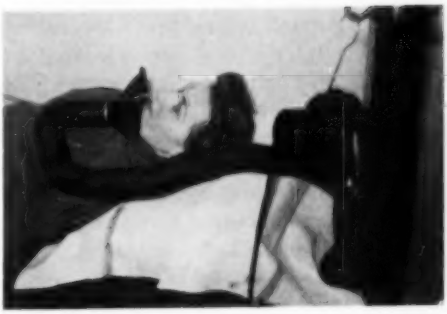

Fig. 2 (Rosner and Gans). The unit in operation.

When such a unit is used in the hospital, the hospital electrician should install the usual operating room shock-proof plug.

Perhaps the chief value of this instrument is psychic—it does make the patient more comfortable and therefore more cooperative to enjoy a refreshing breath of air while he is under the hot and stuffy drapes. Heat and humidity are greatly lessened, oxygen deficiency is eradicated, and the feeling of nausea and suffocation is reduced.

Rose Building.
Keith Building.

* This instrument can be obtained from The A. E. Owens Company, 4710 West 146th Street, Cleveland 11, Ohio.

OEDIPISM

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Oedipism, as distinguished from the Oedipus complex, is defined in Dorland's *Dictionary* as "Self-inflicted injury to the eyes." Both are psychoneuroses and get their name from Oedipus, King of Thebes. According to Bullfinch's mythology, at Oedipus' birth it was predicted that he would kill his father and marry his mother. He was there-

upon cast away and brought up not knowing his parents, but in due course he encountered, fought with, and killed his father. Then he guessed the riddle of the sphinx who had been terrorizing Thebes causing the monster to kill herself in her chagrin. The people of Thebes gratefully asked him to marry their queen and become king of Thebes. This he did, but Thebes fell on evil times and when the oracle was consulted, it was discovered that Oedipus had murdered his father and married the Queen, his mother. When told of his crimes, Oedipus went mad and tore out his eyes; hence the word "Oedipism."

There are not many cases of self-inflicted eye injuries recorded in American medical history—probably many have been overlooked. One must differentiate between malingering and true self-inflicted injury, which can vary from a very slight irritation of the eye to major damage to the globe itself.

Many substances have been used to induce injury, these have been as diverse as crumbs of tobacco or strong chemicals that burn the eyeball, or hard substances that penetrate.[1] The common cases result in conjunctivitis, varying from mild erythema to severe purulent conjunctivitis. One of the differential points in diagnosis is freedom from bacteria in the conjunctival sac. Usually many polymorphonuclear leukocytes and frequently eosinophils are found on examination of the exudate. Since the substances are ordinarily put in the lower cul-de-sac, the lower bulbar and palpebral conjunctiva are involved rather than the entire eye or the upper part.

A number of reports have appeared in foreign literature regarding self-inflicted injuries of the eyes. The majority have been in soldiers attempting to escape unpleasant duty. Somerville-Large reported 375 cases in native troops in India during World War II[2]; Somerset had 31 cases more in India,[3] and Roper-Hall, 22 cases in native soldiers in the Suez Canal Zone.[4]

Somerville-Large never actually found a foreign substance to remove, nor could he obtain a witness who had seen a soldier putting anything in his eye. His cases were all severe. The commonest substances used were castor oil and jequirity seeds. There was edema of upper and lower lids, a pseudomembrane sometimes attaching the lower lid to the globe, and at times there was chemosis and an enlarged preauricular gland. Recovery was complete with minimal treatment.

Severe mutilation of the eyeball has been reported occasionally. Soeb[5] reported the case of an epileptic who tore out his left eye with his fingernails, and then used his nails to lacerate the right eye through the eyelid. Byrnes and Shier[6] described a patient who made several attempts to destroy his eyes. Three times he used a spoon handle, and the last attempt resulted in partial avulsion of the optic nerve of the left eye.

Case reports

Two very different but interesting cases of Oedipism are reported here.

Case 1

Pfc. M. was a prisoner-of-war in the Philippine Islands during World War II. He was a 23-year-old white man first examined by me at the Prison Hospital at Camp No. 1, Cabanatuan Nueva Ecija P.I. on September 25, 1943. I was called to see this patient at "bango" time (morning roll call), about 7:00 a.m. The preceding night he had slashed his throat and wrists with a razor blade. Since at that time I was doing otolaryngology as well as ophthalmology, I took the man to surgery and sutured the lacerations under local anesthesia. That particular day the prison hospital was being moved to a different part of the camp approximately one-quarter mile away. Patients, equipment, and even a few small bamboo buildings had to be moved by manpower. There was some turmoil upon reorganization that night. The patient had been transferred

from a medical ward to the so-called "locked ward," a bamboo building reinforced with wood. Approximately one week later, when he was being brought to the Eye, Ear, Nose and Throat Clinic, he dove into a ditch. This was assumed to be with suicidal intention, although he did no harm to himself.

Three days after the suicide attempt, this patient broke a spoon with which he was eating his rice and, using the jagged end of the handle, stabbed himself in the conjunctivas and corneas of both eyes, causing definite abrasions and minute lacerations of the bulbar conjunctivas of both eyes with some scratches on the cornea. At the same time he used the spoon to reopen the original laceration of his throat. This necessitated resuturing his trachea as well as eye treatment.

There was marked shortage of all types of drugs in the prison camp. The man had been given sulfathiazol by mouth after the original injury to prevent any possible infection, but with the shortage of drugs it was felt inadvisable to use more sulfathiazol as this problem might occur a third time. The only eye ointment available was yellow oxide of mercury, and this was placed in both eyes, and they were occluded. The wounds healed well within a few days.

Going into the patient's history in an attempt to explain his behavior, it was found that this patient had suffered from malarial fever; however, that seemed to be under control at the time of this incident. He certainly did not have cerebral malaria. Considerable questioning by a very able psychiatrist and by me revealed a syphilophobia. As a form of treatment to rehabilitate him in camp and to humor him to a certain extent some injections of calcium chloride were given intravenously. This caused sensation of generalized warmness. It was impossible to do any serologic test in the camp even if there were a likelihood of syphilis. Unfortunately, the patient was not satisfied and insisted that he was not given the right medication.

After a few days, the worry over syphilis was changed to a complaint of being "eaten up" inside by amoeba. Amoebic dysentery was extremely common in camp and was a definite worry to everyone. As we did have a microscope, daily tests were run at the laboratory but uncovered no evidence of amoeba at this time.

Three weeks after the original injury the patient again cut his wrists with a razor blade and gouged his eyes with a spoon. The resultant injuries were not as severe as on the first occasion. The wrist laceration was superficial. The eyes again responded well to treatment. A few days thereafter, this man escaped from camp.

It might be stated that a sane man would not have attempted to escape from this camp for it was in a flat open plain surrounded by a barbed wire fence. There were 20-foot high guard towers at intervals of 100 feet with lights on all night and guards constantly on duty. This man escaped at roll call one morning. At that time roll call was held before sunup. He was not missed until after breakfast. He had gone through the barbed wire, undetected by the Japanese guards. When it was reported later that a prisoner was missing the Japanese were in a state of excitement and we spent most of the day searching for the lost man. The Japanese searched the surrounding countryside including a town six kilometers away. He was not located. The Japanese now assumed that the locked ward patients were seriously demented and put more guards on duty. More boards were put on the locked ward and the prisoners were not allowed freedom for exercise or even washing.

One week after the escape, while a detail of Americans were working in a cornfield about two kilometers from camp, this unfortunate patient was discovered in a haystack. He had been living on raw corn and raw sweet potatoes for a week and was in poor condition physically. The Japanese again were very excited. The man was brought back to camp on a litter. I had no opportunity, nor did any American doctor, to

examine him at this time. He was taken to the Japanese part of the camp. Later in the evening, the Japanese doctor reported to the American commanding officer that his first sergeant had to shoot this man because he was psychopathic.

CASE 2

The second case was seen at St. Vincent's Hospital in Los Angeles, California. I was called about 10:30 o'clock on the evening of February 24, 1950, to examine a 32-year-old white woman, Mrs. C., a nurses' aid in the obstetrical department at the hospital. About 8:00 p.m., according to her story, she had dropped a water glass into a sink and a fragment of glass had struck her right eye. No one had seen this happen. She said that the glass was completely destroyed. Since she was well liked, it never occurred to anyone to question the truth or the motive of her story. The house doctor on duty, a resident in general surgery, had seen her and found no evidence of serious injury, but suggested that I examine her.

I found a very minute superficial laceration on the margin of the right lower lid. There was no evidence of foreign body, and no evidence of staining of the cornea with fluorescein. Some butyn-metaphen ointment was prescribed, the eye patched, and the patient told to come to the office the next day for examination. The following day, vision was found to be 20/30, R.E.; 20/20, L.E. The media were clear and the fundi were normal. The extraocular muscles and pupillary reflexes were normal. There were a few superficial punctate stains of the right cornea. The patient was told to continue using the butyn-metaphen ointment and no further trouble was anticipated.

On February 27th, the patient returned to the office and several small pieces of glass were found and removed from the lower cul-de-sac. The eye was thoroughly irrigated and rechecked with the slitlamp and butyn-metaphen was ointment instilled. Empirin compound with codeine was prescribed for home use.

The patient came back on February 28th. There was a laceration on the bulbar conjunctiva below, and more glass was removed from the cul-de-sac.

On the next day, the patient complained of aching and pain in the eye. There were many punctate stains. In order to rule out any possibility of a large piece of glass being in the eye, although this seemed highly improbable, an X-ray study was ordered. No foreign body was seen. Because of the many punctate stains, aureomycin drops every two hours were prescribed.

The following day the patient was examined in consultation by Dr. John P. Lordan. He could find no evidence of a foreign body. He instilled atropine in the eye.

On March 3rd, a small glass foreign body was removed from the cul-de-sac. Penicillin ointment was prescribed. On March 4th there was no stain on the cornea and no foreign body, and we felt the patient was on the road to recovery.

On March 6th, there was bleeding from the conjunctiva and a small piece of glass was removed. The media were clear and the fundi normal.

On March 7th the patient complained of a rough feeling in the eye. The patient was told to go home and go to bed and to keep both eyes patched but, as she had to work that evening, she was seen at the hospital later and was definitely complaining of pain.

She was not seen again until March 9th, at which time she stated that she took Demerol. Her husband was a medical student and it was possible that he could obtain this. I had not prescribed it for her. The amount taken was unknown. The question of addiction arose but was later disproved. I made a note that day as to the possibility of a factitial lesion. There was punctate bleeding from the conjunctiva that day, and obvious pain.

On March 11th, a small piece of glass was removed from the conjunctiva and two more were removed from the cul-de-sac. On March 14th, there was diffuse staining of the

right cornea but no evidence of foreign body. On March 16th, there was no stain of the cornea. The patient stated that she took out a piece of glass by herself.

On March 18th, there was slight bleeding. The patient stated there was slight bleeding the day before but I could find no evidence of any bleeding point or stain of the cornea. On March 20th, the patient was asymptomatic.

The patient returned to the office on March 25th at which time there was no stain and no foreign body, but the patient complained of a little blur in the left eye, and the vision in that eye which had been 20/20 was now 20/30. The patient did not return until April 5th, at which time she stated that she had been all right until the preceding day. The eye was red and there was injection of the bulbar conjunctiva but no evidence of foreign body or stain of the cornea.

On April 6th, two pieces of glass were found on the dressing. There was slight hemorrhage of the conjunctiva and a few punctate stains of the cornea. The patient came back at 5:00 p.m. that night and there was a piece of glass on the lower lid. The next day, two lacerations of the bulbar conjunctiva were seen and there were definite excoriations of the cornea. On April 10th, several pieces of glass were removed with moderate hemorrhage of the conjunctiva. Next day, more glass was removed. On that day the patient was admitted to St. Vincent's Hospital for further observation.

I might emphasize that this attendant had been working at the hospital for one year and a half and had been very popular with the members of the department in which she worked. She appeared to be a very reasonable person, working to help her husband attain his education. She had one daughter, aged 12 years, and all in all seemed to be a happy, adjusted person.

On April 12th the patient was taken to surgery and under pentothal anesthesia a thorough search of the conjunctival sac was made, even to an incision in one of the lacerated areas. There was no evidence whatsoever of any foreign body. The patient was kept in bed for several days with both eyes covered and the eye healed well. From that time on we had no further difficulty.

We finally obtained a story from a nurse who had seen the patient break a glass eyedropper and put the glass in her eye. She had not reported this to the head nurse, nor to anyone else. The patient was discharged from the hospital on April 22, 1950, and was last examined two weeks later at which time there was 20/30 vision in the right eye and 20/20 in the left. A −0.25D. sph. gave her 20/20 vision in the right eye. Her only statement at this time was that she had lost her job because of the eye problem and felt that she had been discharged unfairly.

1930 Wilshire Boulevard (5).

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CORNEAL FOREIGN-BODY AND RUST-STAIN FORCEPS*

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In removing corneal foreign bodies and especially rust and other stains, one often feels the need of grasping the loosened material which may adhere to the cornea by a shred. One cannot do this with a spud. A forceps with a flat blade on each side, slightly larger than one-half mm. in width, for scraping and grasping has been found to be very satisfactory.

The forceps has branches and a body like a conjunctival dressing forceps with each branch ending in a flat spud about two mm. long and one-half mm. wide. The spuds turn in and down and meet one another at an angle slightly greater than 90 degrees.

I have found it more convenient to work with the patient lying down rather than having him at the slitlamp. I use an eye operating lamp on a stand and, for magnification, a small 10-power folding loupe. If necessary an eye speculum is also used.

The forceps has been used in two ways. Each flag-shaped branch has been used as a spud first working from one side and then from the other and then both together as a forceps to lift loose material.

Another method was first to remove the foreign body, if present, with the instrument as a forceps and, then, if a stain remained or if only a stain were present, the flat one-half mm. edge of each branch was placed one on each side of the stain. The branches were brought together by pressure of the thumb and forefinger and then lifted. Usually only one tip moves. This maneuver is repeated until the area is clear.

Both methods, of course, are frequently combined. The flat tip of the forceps moves parallel to the surface of the cornea and does not dig as deeply into it as a pointed forceps might. The corner of the blade is still pointed enough to remove pinpoint material.

1020 First National Building.

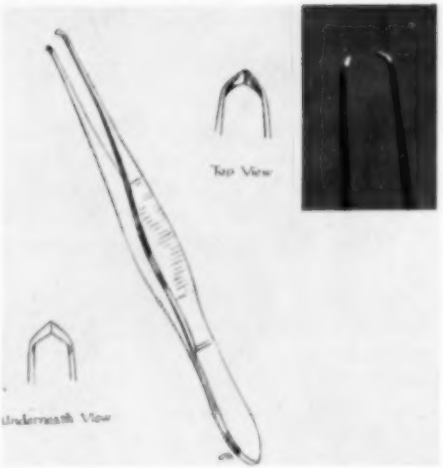

Fig. 1 (Manning). Forceps for removing corneal foreign bodies and rust stains.

* Made by the Storz Instrument Co., Saint Louis, Missouri.

OPHTHALMIC MINIATURE

Generally speaking, the employment of glasses and the choice of the particular form of glass, is left to the public and the optician; they are subjects on which the former think they are quite sufficiently instructed to judge, and the latter, for arguments to which human nature generally gives way, see no reason to undeceive them.

W. R. Wilde,
British Medical Journal, 1847.

SOCIETY PROCEEDINGS

Edited by DONALD J. LYLE, M.D.

NEW YORK SOCIETY FOR CLINICAL OPHTHALMOLOGY

May 3, 1954

DR. BERNARD FREAD, *President*

ROUND-TABLE CONFERENCE

SUBJECT: GLAUCOMA

DR. PAUL A. CHANDLER, DR. ADOLPH POSNER, DR. ALGERNON B. REESE, AND DR. SAUL H. SUGAR comprised the panel of discussors; DR. BERNARD FREAD acted as moderator.

1. What factors influence your choice of operation in narrow-angle glaucoma? Do you favor peripheral iridectomy in the fellow eye in acute or subacute narrow-angle glaucoma?

DR. CHANDLER said that the principal factors influencing choice of operation are the stage of the disease and the response to medical treatment. In acute glaucoma peripheral iridectomy is chosen for all cases regardless of duration, when the tension can be normalized preoperatively with medical treatment.

For cases of acute glaucoma of two or three days or longer duration, in which the tension cannot be lowered preoperatively by medical means peripheral iridectomy with freeing of peripheral anterior synechias and air injection is chosen. In some of the more neglected cases there may be enough residual glaucoma to require further medical or surgical treatment.

Filtering operations are often chosen as the initial procedure for these neglected cases, but my experience has not been favorable. The hazards of filtering operations are much greater than those of peripheral iridectomy.

Many of us have pointed with pride to cures with iridencleisis when there was no evidence of filtration whatever. The cure has resulted from the coloboma of the iris and could have been much more simply and safely accomplished by peripheral iridectomy.

In subacute narrow-angle glaucoma, choice of operation depends on the stage of the disease and the response to miotic treatment. For the early cases with minimal or no field changes peripheral iridectomy is chosen. For the moderately advanced cases with moderate to severe disc changes and field loss, if the tension can be normalized with reasonable use of miotics, peripheral iridectomy is chosen though there is a prospect of the necessity of miotic treatment postoperatively.

For the moderately advanced and advanced cases in which the tension cannot be normalized by reasonable use of miotics and the angle is largely closed by peripheral anterior synechias, a filtering operation is chosen. Except in aged and debilitated patients, I favor prophylactic peripheral iridectomy for the fellow eye in cases of acute or subacute narrow-angle glaucoma. If properly performed, it is a simple and safe procedure and offers complete protection against future glaucoma. Statistics prove that in cases of narrow-angle glaucoma, the fellow eye is affected sooner or later in a high percentage of cases. I believe that prophylactic peripheral iridectomy is one of the most effective public health measures at the disposal of ophthalmologists.

2. What provocative tests do you use in your routine office practice?

DR. POSNER said that the two provocative tests which he uses routinely are the dark-room test of Seidel and the water-drinking test of Marx and Schmidt. The dark-room test is used in narrow-angle glaucoma and the water test in chronic simple glaucoma. He also uses the lability test of Bloomfield and Lambert in those cases in which the water test gives an equivocal result.

Before using any provocative test, it is

essential to have clearly in mind the type of glaucoma which is suspected.

The dark-room test is the best provocative test for narrow-angle glaucoma. It should be performed whenever there is a history of symptoms and the angle is narrow. It may constitute the only diagnostic finding. The patient is placed in a completely dark room for one hour and is instructed not to fall asleep. Sleep stimulates the parasympathetic system and contracts the pupils. Darkness dilates the pupils. If a dark room is not available, he is put in a semidark corner and a black cataract mask is applied. The tension is taken after one hour. A rise of tension of 10 mm. Hg is considered positive. Sometimes the tension rises to 50 or 60 mm. Hg. The dark-room test is a physiologic provocative test since patients usually get symptoms in the evening or at movies.

The water-drinking test is performed in a borderline case of chronic simple glaucoma. The anterior chamber may be either deep or shallow. In a typical case, the patient gives no history of symptoms but the tension is borderline or slightly elevated, or the tensions of the two eyes differ by 5.0 mm. Hg or more. If the patient is using drops, he is instructed to stop miotics for 24 hours and to have no liquids with his breakfast on the morning of the test. The tension is taken and he is given one liter of water to drink. Tensions are repeated every 15 minutes. In normal eyes, the highest tension is usually obtained within one hour and the rise is not greater than 4.0 mm. Hg. A rise of 8.0 mm. Hg is considered positive.

The lability test is easily and quickly carried out. It was devised by one of our members, Dr. Sylvan Bloomfield. Dr. Posner said he would not go into the technique which can be found in Dr. Bloomfield's publications. It is valuable in borderline cases. Dr. Posner said he considers a rise of 10 mm. Hg or more as positive.

In a case which cannot be classified with certainty as either narrow-angle or chronic simple glaucoma, the response to one or the other of the provocative tests may supply valuable clues.

3. Following cataract extraction, glaucoma develops in some cases: (a) What are the causes? (b) How do you avoid it? (c) How do you treat it?

Dr. Reese said that, when the epithelium gains access to the anterior chamber it may form either a localized cyst or grow along the surfaces. In either case, glaucoma may ensue. The treatment for the cyst is either excision or obliteration by diathermy. The treatment for epithelization of the walls of the anterior chamber is by low-voltage X rays. As other clinical pictures simulate epithelization of the anterior chamber, it is well to remove a small bit of the iris and determine whether or not epithelization is present by microscopic study before subjecting the patient to X-ray treatments.

A shallow anterior chamber during the postoperative course can predispose to glaucoma. The causes may be: (1) Pupillary block, the treatment for which is iridectomy; (2) a leaking wound, the treatment of which is repair; (3) a detachment of the choroid, which is coincident with a shallowing of the anterior chamber. (This may be a separate and independent cause or may be related to the first two enumerated.); (4) presumably aqueous could get back of the detached vitreous, according to the concept of Schaffer, and the treatment here would be aspiration.

Regardless of the cause of the shallow anterior chamber, the large majority of cases can be satisfactorily corrected by the injection of air into the anterior chamber together with a posterior sclerotomy. Some cases of postcataract glaucoma are really primary glaucoma not appreciated preoperatively. There seem to be other cases, though, in which the eye has a low aqueous-outflow reserve or potential and the cataract operation has tipped the balance toward the glaucoma. In other words, these would be cases of potential open-angle glaucoma with probably a decrease in the facility of aqueous

outflow before an operation was performed.

4. What is the significance of the depth of the anterior chamber in the classification of glaucoma? In a patient with a shallow anterior chamber, how do you know if you are dealing with a noncongestive phase of narrow-angle glaucoma or with chronic simple glaucoma?

DR. SUGAR said that the present-day practice of dealing with a classification of adult glaucomas is to designate them according to the chamber angle depth. This usually, but not invariably, correlates well with the actual depth of the anterior chamber axial depth. We use the term "narrow-angle glaucoma" for the acute type, and "open-angle glaucoma" for the chronic simple type.

These terms, "narrow" and "open," although they are not antonyms are significant in relation to each other. They indicate that the salient feature of acute glaucoma is narrowness of the chamber angle which leads to obstruction of the outer channels.

On the other hand, the angle in simple glaucoma is normal. It varies from wide to relatively narrow but is characterized by an absence of visible obstruction in the angle.

The glaucoma here is not related to the angle depth at all. In a patient with elevated tension and a shallow anterior chamber it might be difficult to distinguish between narrow-angle glaucoma in the noncongestive phase and chronic simple glaucoma. Gonioscopy is the best means for making the distinction. If the angle is open gonioscopically, while the tension is elevated, the narrow-angle mechanism is ruled out.

5. What factors are of principal importance in avoiding complications with peripheral iridectomy?

DR. CHANDLER said that the principal factors in avoiding complications in peripheral iridectomy concern the incision, the method of grasping the iris, and closure of the wound. A keratome or knife may be employed or the incision may be made ab externo. For the average surgeon, with the keratome incision there is risk of splitting the cornea on the one hand, or injuring the lens on the other. The knife incision for technical reasons must be longer than necessary, is more at right angles to the sclera and hence more difficult to close tightly.

The ab externo incision Dr. Chandler believes is the simplest and safest. It is begun 1.5 to 2.0 mm. from the limbus, slanting toward the angle of the anterior chamber. There is no risk of injuring the lens, since the instrument is at all times peripheral to the lens. The iris is not injured when the anterior chamber is opened since it pushes ahead of the knife. The incision should not be longer than three to four mm.

After the anterior chamber is opened, if the iris cannot be made to prolapse, a spatula should be introduced to free possible anterior synechias; otherwise, the iris may be torn or the lens injured in introducing iris forceps. Only iris forceps without teeth should be used on account of the danger of injuring the lens.

Dr. Chandler said he thought it is imperative that the incision be tightly closed with a deep scleral suture. Statistics of a series of successful cases without sutures are small comfort to the occasional patient in which the anterior chamber remains flat as a result of a leaking wound. He said he has seen eyes lost as a direct result of a leaking wound and a flat anterior chamber, resulting in complete peripheral anterior synechias.

6. What methods and criteria do you consider adequate for perimetric study of a case with borderline tension increases for the purpose of (a) diagnosis; (b) operation?

DR. POSNER said that perimetry is an important aid in the early diagnosis of chronic simple glaucoma. To be of value, it should be carried out carefully and accurately both on the perimeter and the tangent screen. With the perimeter, Dr. Posner usually uses the one- or two-mm. white test object. With the Harrington black light perimeter, the one-mm. test object is sufficiently large in most cases.

The field and blindspot are then plotted on the tangent screen at one meter, using the one- and two-mm. white test objects.

In chronic simple glaucoma, the development of field defects proceeds in a fairly characteristic sequence: Widening and accentuation of angioscotomas, enlargement of the blindspot, nasal step, baring of the blindspot, Bjerrum scotoma, nasal quadrant defect, and merger of the Bjerrum scotoma with the nasal quadrant defect; a juxtacecal step develops in some cases.

It is important to adopt a technique which is adequate to elicit field defects in the early stages. An early nasal step, which is so diagnostic, may be detected by moving the test object vertically across the horizontal meridian. Short, discontinuous movements, interrupted by pauses, are better than continuous movements. The "rapid comparison test" described by Dr. Chamlin is admirably suited for this purpose, as well as for detecting vertical hemianopic types of defects. Minimal test objects should be used to map out early Bjerrum scotomas. Angioscotomas can be mapped on the tangent screen if illumination is kept down to three to four foot-candles and if the test object is moved slowly or in discontinuous fashion in a direction perpendicular to the expected border of the scotoma, as was emphasized by the late John Evans.

In a case of chronic simple glaucoma with normal or borderline tension, the question of operation often hinges on the finding of progressive field loss. In such cases, the field should be mapped out carefully on the tangent screen always using the same size test object and the same illumination, and the test should be performed as much as possible at the same time of day. It is not necessary to map the entire field. If time is a factor, only the border of the nasal defect or the width of the Bjerrum scotoma need be studied at repeated tests.

In narrow-angle glaucoma, perimetry is relatively unimportant either in establishing the diagnosis or in deciding the need for surgical intervention. The diagnosis should be made from history, slitlamp and gonioscopic study, and from the results of provocative tests. The decision as to the necessity for surgery and the type of operation depends on the severity and frequency of acute attacks, the presence or absence of congestion, the degree to which miotics control symptoms, and the height of tension between attacks.

In the early stages, or even in a case of several years' standing, which has been subject to repeated noncongestive acute attacks, the field usually is normal. After a severe congestive attack, almost the entire field may be lost. Less severe attacks may result in field defects of variable extent. The field defect may develop suddenly after an acute attack and then remain stationary for a long time, even if the tension is borderline. In this respect, narrow-angle glaucoma behaves like secondary glaucoma. The field defects may be similar to those found in chronic simple glaucoma but certain differences are discernible in many cases.

Most commonly, the defect assumes the shape of a sector originating in the blindspot and bears a definite relationship to one or more angioscotomas. It may extend to the horizontal meridian and include one half or less of the fixation area. Occasionally, a central scotoma may result. At times, the field defect bears a striking resemblance to that which is found in closure of a branch of the central retinal artery. The field defect is undoubtedly of vascular origin. It is usually spoken of as a nerve-fiber bundle defect but Dr. Posner preferred to call it a "sector defect" which is a more noncommital term.

7. What is the frequency of cataract after filtering operations and how do you operate for the cataract?

Dr. Reese eliminated from the discussion the cases in which there had been injury to the lens capsule.

In a given age group the incidence of cataractous changes would be greater in

eyes with primary glaucoma than in non-glaucomatous eyes. All glaucoma operations tend to cause cataractous changes to progress. Some operations are greater offenders than others. If cataractous changes are present, it is well to tell the patient of their presence and advise that antiglaucomatous surgery may hasten their development.

If there is good filtration, and the intraocular pressure is well within normal limits, Dr. Reese said he does not hesitate to make the usual section at the limbus disregarding the filtering bleb; if miotic drops must be used, then Dr. Reese prefers to make the incision in the cornea just central to the filtering bleb.

8. What would you do in a case of glaucoma in which the tension remains under 32 mm. Hg but the field is shrinking in spite of the use of pilocarpine? Does surgery arrest the loss of field?

Dr. Sugar said that in a patient in whom the tension with miotics remains under 32 mm. Hg, but the field is shrinking, he would determine if the ocular rigidity is normal, and would tend to avoid surgery. The basis of his opinion is the conception of a vasoconstrictor cause for glaucoma simplex.

The vasoconstrictor factor may be a neurovascular stimulus or may be sclerotic in nature. If the vascular changes predominately involve the anterior vessels around the Schlemm's-canal mechanism, the tension rise might be expected to precede field and disc changes. If the vascular changes occur coincidentally in both the anterior vessels and those which are nutrient to the optic nerve, coincidental rise in tension and disc and field changes may be expected.

If the optic-nerve changes are predominant, the field and disc changes may precede the tension rise. In such a case, if the field changes are relatively advanced and the tension rise early, surgery would not be expected to hinder materially the deterioration of the field. Surgery would possibly even cause added difficulty.

In the practical handling of a case of this sort, one must evaluate the picture as a whole.

Dr. Sugar said that what he has stated so far is a principle. If both eyes show similar changes, he believes it would be wise to operate on one eye only, to take advantage of maximum gain and suffer minimal loss.

9. What techniques can you advise for tonography in routine office practice?

Dr. Chandler said that he did not feel properly qualified to answer this question but, having consulted Dr. Morton Grant, he hoped he was quoting him correctly.

In the first place it takes considerable practice to do tonography accurately. The curves obtained by the beginner are invariably irregular in contour and difficult to interpret. A fixation target on the ceiling is important.

The foot-plate of the tonometer should be held above the eye for several seconds, then gradually brought down onto the cornea so that the patient is unaware when the procedure is actually begun. The operator must watch the eye and the tonometer constantly to make sure the foot-plate of the tonometer does not slide to one side or the other of the cornea, and the tonometer is in a vertical position.

The room should be free of any extraneous noises. One should not talk to the patient during the test.

Dr. Chandler said that his own personal feeling is that tonography is primarily a research tool and need not be used by the average ophthalmologist. Let it be done by a few people in each city who become skilled in the procedure.

Tonography has been of inestimable value in confirming the essential difference in open-angle and narrow-angle glaucoma, and in establishing the fact that resistance to outflow of aqueous is the sole cause of the rise in pressure in glaucoma. In the future, Dr. Chandler believes its continuing and principal value will be as an aid in diagnosis in questionable cases of glaucoma.

10. What has been your experience with Diamox in glaucoma?

Dr. Posner said that, from his own experiences and that of some of his colleagues, he would say that, in general, the prolonged use of Diamox in chronic glaucoma of any type is not satisfactory. Large doses tend to give rise to systemic symptoms of toxicity, while small doses soon prove inadequate for maintaining tensions at normal levels.

Diamox finds its greatest usefulness in acute glaucoma, and especially for reducing tension preoperatively both in primary and secondary glaucoma. A large initial dose must be administered: 750 to 1,000 mg., or three to four tablets. Barbiturates or opium derivatives should not be given along with Diamox or shortly before, as these drugs inhibit the diuretic, as well as the tension-lowering, action of the Diamox.

In acute narrow-angle glaucoma, Dr. Posner has observed a most dramatic effect in several instances in which even the strongest miotics were ineffective. Within three hours after the administration of Diamox, the tension often drops to normal or subnormal levels, the anterior chamber deepens and the angle opens. It is important to continue the miotics when using Diamox.

In attempting to explain the mechanism of the action of Diamox in acute narrow-angle glaucoma, Dr. Posner said he must draw upon his concept of the production of acute glaucoma by forward suction of the periphery of the iris.

The narrowest part of the anterior chamber is at the entrance to the angle. If the angle becomes cut off from the rest of the anterior chamber by circumferential contact between iris and cornea in this intermediate zone, then the aqueous contained in the angle is drained off and the root of the iris bulges forward and becomes applied to the trabecula, thus blocking the further outflow of aqueous.

The iris is held there at first by suction, because the pressure in Schlemm's canal is 10 mm. Hg as against 20 mm. Hg, or the average normal intraocular pressure, in the space behind the iris. As a result of the continued interference with outflow, the intraocular pressure rises to abnormally high levels and the iris remains pressed against the corneoscleral trabecula. Stretching the iris by contracting the sphincter may draw the iris away from the trabecula and thus relieve the attack. Where miotics fail, Diamox may succeed.

Diamox reduces the volume of fluid contained behind the iris. When the hydrostatic pressure behind the iris becomes equal to, or lower than, the pressure in Schlemm's canal, the iris is sucked backward in the same manner as it was originally sucked forward, the outflow channels are laid free and normal outflow is re-established.

Diamox has also been found useful in restoring a flat anterior chamber after cataract extraction and in preventing the occurrence of malignant glaucoma after filtering operations. The mechanism of its action in these cases may be similar to that just described for acute narrow-angle glaucoma.

11. What are the indications and your choice of operation in chronic simple glaucoma? What is the value of cyclodiathermy?

Dr. Reese said that by the term "chronic simple glaucoma" he assumed that they were discussing the open-angle type. He said that they know that in this disease the field changes frequently progress, even in the presence of a normal intraocular pressure. This may be due to the fact that, basically, we are dealing with a vascular disease to which the glaucoma is secondary.

In cases of progressing field changes in the presence of intraocular pressure in the high ranges of normal, Dr. Reese said that he is more reluctant to operate, particularly in elderly people in whom cataractous changes are present. We know that many of these patients retain their constricted fields indefinitely even at times when the intraocular pressure is definitely above the normal range. Dr. Reese said that he prefers

to operate therefore, in this type of glaucoma only when the indications are unequivocal. He prefers to do the iridencleisis operation and if this fails to do a trephining operation at the 6-o'clock position.

Dr. Reese employs the cyclodiathermy operation on eyes in which other operations have failed, frequently in aphakic glaucoma, in glaucoma complicated by diabetes, and, if it is ever necessary to operate to relieve symptoms, in cases of sightless eyes. His objection to the operation is that the results are frequently transitory.

12. What do you consider as the indications for cyclodialysis? What is your technique?

Dr. Sugar said that his indications are limited to secondary glaucoma following cataract extraction and secondary glaucoma due to posterior lens dislocation, and as a secondary operative procedure after unsuccessful iridectomy for acute glaucoma in which the anterior chamber is formed. He does not use the operation in simple glaucoma, even though he believes it to be the most physiologic, because the results have been less successful than with the filtering operation. On the European continent, it is still the most popular operation for chronic simple glaucoma. Dr. Sugar believes that modifications of the operation will appear which will improve the prognosis. The technique he has been using is that described by O'Brien.

13. What complications may follow a flat anterior chamber after filtering operations? How do you prevent it and how do you deal with it when it occurs?

Dr. Chandler said that a flat anterior chamber after a filtering operation is always undesirable. The principal complications are peripheral anterior synechias, lens changes, corneal edema, and posterior synechias with or without pupillary membrane.

1. *Peripheral anterior synechias.* If the angle is open preoperatively, as it always is in open-angle glaucoma and often in narrow-angle glaucoma, and if a good filtering scar does not develop, the glaucoma may be made much worse by the operation. Extensive peripheral anterior synechias in cases where none existed before, developing as a result of prolonged absence of the anterior chamber, must be considered a very serious matter. When one looks at eyes postoperatively with the gonioscope it is easy to pick out the cases that have had a flat anterior chamber postoperatively. A flat anterior chamber postoperatively in narrow-angle glaucoma is especially serious since in these cases the filtration apparatus is normal as long as the angle is open.

2. *Lens changes.* Prolonged contact of the lens with the cornea especially in cases with exfoliation of the lens capsule may result in anterior capsular and subcapsular opacities which seriously impair visual acuity.

3. *Corneal edema.* In predisposed eyes with a defective corneal endothelium, prolonged absence of the anterior chamber may result in permanent edema of the cornea and loss of all useful vision. The presence of corneal edema in cases of flat anterior chambers makes it imperative that measures be undertaken without delay to reform the anterior chamber.

4. *Posterior synechias.* While the chamber is flat it is impossible to dilate the pupil to any extent, hence complete posterior synechias and even an inflammatory pupillary membrane may develop in eyes with postoperative iritis. This may seriously impair the function of the eye even though the glaucoma is relieved.

Dr. Chandler said that he did not know of any certain method of preventing a flat anterior chamber after filtering operations. He said he was convinced, however, that the smaller the conjunctival incision and the tighter the closure, the less is the incidence of a flat anterior chamber. He said he was sure that a leak of the conjunctival wound is one of the factors contributing to a flat anterior chamber.

When should one interfere in cases of flat anterior chambers after filtering opera-

tions? Dr. Chandler said there is no unanimity of opinion in regard to this question. His own practice is to interfere on the fourth or fifth day depending on the size of the pupil and the state of the cornea.

To reform the anterior chamber, the sclera is trephined 10 or 12 mm. from the limbus usually in the lower outer quadrant to release the subchoroidal fluid, and air is injected into the anterior chamber through a slanting incision in the lower cornea. In his experience he has not known this procedure to fail in reforming the anterior chamber. The trephine blade is applied at an angle to the sclera so that the button is not entirely removed but the opening may continue to drain. If the subchoroidal fluid is released by a simple knife incision, the anterior chamber may remain flat when the air is absorbed from the chamber.

14. What are the criteria for diagnosis of glaucomatocyclitic crises and what is your management of these cases?

Dr. Posner said the name "glaucomatocyclitic crises" was coined by Dr. Schlossman and him to identify a group of cases which were described by them as a syndrome in 1948.

Dr. Posner said that they now find the cases are not as rare as they originally supposed and he was sure that many ophthalmologists have encountered them in their practices. However, such cases are frequently overlooked, or else mistaken for other types of glaucoma.

The clinical course of this syndrome is so characteristic that often the diagnosis will suggest itself from the history alone, even before the patient is examined.

The patient gives a history of recurrent attacks of blurred vision and halos limited to one eye and always the same eye. Pain and redness are lacking or minimal. The pupil is usually somewhat dilated during the attack, the tension is elevated, and there is edema of the corneal epithelium if the tension is over 45 mm. Hg (Schiøtz). The attack subsides spontaneously without treatment after periods varying from several hours to several days. Visual acuity is not greatly impaired, even at the height of the attack and returns to normal after the attack. The field remains normal and the disc shows no excavation. The mildness of the symptoms in the presence of relatively high tension is characteristic of the syndrome and is a significant diagnostic feature.

It is only by slitlamp examination that the diagnosis may be established. In a typical case cells are seen in the aqueous in the early stage. Later a few small, flat, unpigmented keratic precipitates are found. Aqueous flare is not prominent. When the tension is high, the cells and keratic precipitates may be masked by the corneal edema. Cells and keratic precipitates still may not be seen for two to five days after the onset of the glaucoma. Occasionally, keratic precipitates may be absent for the duration of one attack and appear during a subsequent attack. Posterior synechias almost never form. The anterior chamber may be of variable depth but the angle is always open.

Although the syndrome of glaucomatocyclitic crises is etiologically related to secondary glaucomas, clinically it is more often mistaken for acute narrow-angle glaucoma. In any case of acute glaucoma in which the angle is not found to be narrow or in which it remains open during an attack, the diagnosis of narrow-angle glaucoma should be doubted. Even if no keratic precipitates are found, diagnosis should be deferred until the case has been studied, with the possibility of this syndrome kept well in mind.

The necessity for differentiating the syndrome of glaucomatocyclitic crises from narrow-angle glaucoma is of practical importance in determining the course of treatment. Dr. Posner said that he emphasizes again that the attack of the syndrome is self-limited, that it subsides spontaneously, and that it generally leaves no evidence of impairment of function, no matter how high the tension may be during the acute phase.

In the presence of high tension, one is

tempted to "do something," either to use strong miotics or to resort to operation, if only paracentesis. Strong miotics, such as eserine and DFP are definitely contraindicated. They can produce pain, congestion, and spasm of the ciliary muscle. Surgical procedures, whether iridectomy or fistulizing operations, do not prevent recurrences. Pilocarpine, one or two percent, may be prescribed. Neosynephrine, 10 percent, may best be used in the office as a mydriatic in order to ascertain that no posterior synechias are forming. Topical cortisone may be used to suppress the cyclitis. Naturally, the patient's apprehensions should always be relieved by convincing reassurance from the physician that the prognosis is extremely favorable. No treatment is indicated during the intervals between attacks.

15. (a) What is your method of the iridencleisis operations? (b) What are the indications and manner of doing a paracentesis?

Dr. Reese said that, in performing an iridencleisis operation, he preferred to produce an iridodialysis when the iris is withdrawn or at the time the keratome section is made. A radial cut is made into the iridodialysis opening. This produces, in effect, a basal iridectomy over the site of the coloboma. This, therefore, prevents this part of the angle from being obliterated by the withdrawn iris. Also, Dr. Reese thinks it is important to try to preserve the pigment epithelium. Surfaces covered by epithelium do not adhere and, if we can produce an iris wick with the epithelium inverted, we have a better chance for filtration. The iris normally tends to curl with the pigment epithelium.

Dr. Reese thinks a paracentesis is a valuable therapeutic measure to overcome aqueous stasis in the presence of inflammation which is producing secondary glaucoma. He is opposed to doing a paracentesis through the cornea and trying to open the wound each day with a spatula. He prefers to make the section under a conjunctival flap far back at the limbus, which is customary as an antiglaucomatous measure. Each day following this procedure the eye is massaged.

16. Discuss the physiologic basis for the action of miotics and iridectomy in narrow-angle glaucoma.

Dr. Sugar said that the miotic drugs act by freeing the entrance to the trabecular spaces from the obstructive effect of iris block. Occasionally, the miotics cause an increase in pupil block and may precipitate an acute attack. A drug, such as DFP, by its congestive effect on the ciliary body, may block the angle more directly.

Successful iridectomy has the following requirements:

(1) The angle must be open in at least 45 or 60 degrees of the angle circumference, (2) a communication must be formed between the anterior and posterior chambers. If these requirements are met, the periphery of the angle is deepened, and mydriasis no longer causes a rise in tension.

Peripheral iridectomy is done when no significant previous blockage of the angle has been present. According to Barkan's theory, the iridectomy deepens the peripheral portion of the anterior chamber by preventing pupil block, which is the cause of physiologic iris bombé.

Basal iridectomy acts by relieving the angle block, directly by excision of iris, and, indirectly by manipulation of the iris. In addition, the formation of communication between anterior and posterior chambers occurs. The pupil block probably depends entirely on the forward position of the lens by retention of fluid in the vitreous, induced possibly by increased aqueous formation. Barkan based his theory on the axial deepening of the anterior chamber following iridectomy for acute glaucoma.

In refutation of this idea, Dr. Sugar said that he found that acute glaucoma, provoked by pupillary dilatation, showed no change in the anterior chamber depth as measured photographically. The deepening of the anterior chamber after relief from an acute

congestive attack may be explained by the fact that the choroid and ciliary body volume is probably increased by the edema which increases the posterior segment volume and forces the lens forward. After relief of the congestive episode, there would then be return of the lens to its previous position.

17. What is your choice of medical treatment for open-angle glaucoma in people under the age of 40 years?

DR. CHANDLER said that, in open-angle glaucoma in younger individuals, one not infrequently finds wide variations in tension during a 24-hour period, from normal to a tension of 40 or 50 mm. Hg (Schiøtz). The problem is often to prevent the daily rise in tension.

In younger individuals with an active accommodation, miotics in sufficient strength to control the tension are often quite disabling from a visual standpoint on account of the myopia induced. Epinephrine bitartrate in one-percent solution is often extremely helpful in these cases. It has little or no effect on vision and in some cases is very helpful in controlling tension. In the occasional patient, this drop alone is sufficient. In others, a miotic is used morning and night and epinephrine during the day. In the individual patient, the most effective and least disabling combination of drugs is worked out on a trial-and-error basis. To be sure most younger patients with open-angle glaucoma come to operation sooner or later but many can be held for a surprisingly long period with a combination of miotics and epinephrine bitartrate.

18. Can you explain why glaucoma does not occur more frequently in people who have narrow angles of the anterior chamber?

DR. POSNER said that it is a recognized fact that narrow angles are found in the eyes of about five or 10 percent of the population. Yet most of these people never get narrow-angle glaucoma, and those who do may not be affected until some time in adult life or until an acute attack is precipitated by a mydriatic or by an emotional crisis.

It is also well established that, if one eye is suffering from narrow-angle glaucoma and the other eye also has a narrow angle, the second eye may not give subjective symptoms for many years or even for the life of the patient.

In several such cases of unilateral glaucoma, Dr. Posner said he has made the observation that, in the iris of the unaffected eye, there were one or more peripheral crypts located opposite the corneal limbus. These peripheral iris crypts were usually situated where the anterior chamber was narrowest. Dr. Posner believes that these iris crypts play a role in protecting the eye against acute attacks.

An acute rise of tension is initiated by contact between the iris and cornea in this narrow zone. The aqueous contained in the peripheral ring is drained off, the iris is sucked forward and blocks further outflow through the trabecula. An iris crypt, strategically situated in the anterior leaf of the stroma, prevents complete segregation of the two sections of the anterior chamber and thus makes impossible forward suction of the iris. This may be the factor which prevents an attack.

By dilating the pupil a different zone of the iris—one which does not contain a crypt—may form contact with the cornea and an attack may be precipitated. The iris crypt, therefore, does not protect the eye under every condition.

The iris crypts become shallower as the iris stroma atrophies and scleroses with age. This fact may account for the greater incidence of acute glaucoma in the older age groups.

Miotics, especially the stronger ones such as eserine and DFP, stretch the iris and thus tend to flatten or iron out the crypts in some cases. Acute attacks of glaucoma, precipitated by DFP and other miotics, have been reported. Dr. Posner said that he has observed them in two cases after pilocarpine. He therefore does not prescribe miotics as

a prophylactic for the asymptomatic eye if only one eye has narrow-angle glaucoma.

19. To what extent do you advise routine tonometry in the office? Have you found the consideration of scleral rigidity of any practical value in diagnosis or treatment?

DR. REESE said that he thinks the constant use of the tonometer in clinical practice is one of the most rewarding procedures.

He said we must remember that, with the tonometer, we do not measure the pressure of the eye but the tension because of three variable factors: (1) the variation of the size and shape of eyes; (2) the difference in the resistance of the vascular bed; and (3) the variations in the scleral rigidity.

Of these, the scleral rigidity is the one which is of greatest concern. This assumes some importance mostly in elderly people where the elastic-fiber elements of the sclera become less and calcium deposition is common. This accounts for the fact that sometimes we are misled by palpation of the pressure through the upper lid in elderly people.

When the tension is greater with a 10-gm. weight on a Schiøtz tonometer than it is with a 5.5-gm. weight, we can assume that the intraocular pressure is less than measured by the tonometer. When the tension is less with the 10-gm. weight than with the 5.5-gm. weight we can assume that the intraocular pressure is greater than measured. These findings assume importance only in borderline cases.

20. What is the value of gonioscopy in the diagnosis and treatment of glaucoma?

DR. SUGAR said that gonioscopy is not of diagnostic significance in simple glaucoma except to rule out the narrow-angle mechanism in an eye with a relatively shallow anterior chamber. In acute glaucoma it is valuable in recognizing the extent of synechias and in differentiating the acute primary from acute secondary form. It is particularly valuable in the latter. In a secondary glaucoma following cataract extraction, it is diagnostically important. Other forms of glaucoma in which gonioscopy is valuable are: Essential atrophy of the iris, postuveitic glaucoma, glaucoma capsulare, pigmentary glaucoma, glaucoma secondary to tumor growth, and rubeosis irides. In the treatment of glaucoma gonioscopy is of value to determine the site of contemplated surgical procedures by revealing the presence of synechias, and possibly dense scar tissue or large anomalous angle vessels, which may predispose to hemorrhage and other complications.

BERNARD KRONENBERG,
Recording Secretary.

SWISS OPHTHALMOLOGICAL SOCIETY

October 23 and 24, 1954

CASE REPORTS

DR. E. BÜRKE AND DR. M. ROHNER (Basle) noted with the slitlamp in a man, aged 50 years, crystalline deposits in the corneal stroma disseminated throughout the parenchyma of both corneas. Though a diffuse opacity was visible to the naked eye, the visual acuity was: R.E., 20/15, L.E.; 20/15; no inflammatory symptoms were present. The finding of a mild aminoaciduria suggests that the crystalline deposits are probably a precipitation of amino acids.

DR. G. MAEDER AND DR. S. FORNI (Geneva) described a case of malignant hypertensive retinopathy due to pheochromocytoma in a six-year-old boy. Six months after the removal of the tumor, examination with the ophthalmoscope disclosed almost complete regression.

DR. V. BISCHLER AND DR. F. MARTY (Geneva) presented a case of post-traumatic chorioretinopathy of the Siegrist-Hutchinson type. After a football injury, ophthalmoscopy revealed in one eye just above the macula a somewhat round yellowish plaque, two disc diameters in extent, flecked with pigment. Subchoroidal hemorrhage is suggested as the cause.

Dr. E. Rosselet and Dr. V. Michels (Lausanne) cited two cases of thrombosis of the central retinal artery occurring with intermittent claudication which they consider as examples of Horton's disease.

Dr. R. Dufour and Dr. S. Welter (Lausanne) reported a case of retinal periarteritis in a patient with generalized vasculitis. The ophthalmoscope showed cotton flakes about the arterioles. The condition is apparently associated with a type of sensitivity reaction.

Dr. J. F. Cuendt, Dr. O. Ritter, and Dr. P. Miescher (Lausanne) discussed a case of recurrent thrombophlebitis of the retinal veins. Attacks have occurred every summer for the previous five years. They considered bacterial allergy as the probable cause and administered a polyvalent vaccine between attacks and an anticoagulant during the period of thromboses.

Dr. H. Heinzen and Dr. E. Baasch (Zurich) presented a case of congenital myasthenia gravis with general muscular weakness, bilateral ptosis, and ophthalmoplegia externa. Only five congenital cases have been reported previously. The ptosis and muscular weakness were dramatically improved by the administration of prostigmine but the ophthalmoplegia externa remained unchanged. The electromyogram gave a typical myasthenic reaction in all the muscles examined.

General observations

Dr. A. Verrey (Lausanne) discussed the cases of epidemic keratoconjunctivitis seen in the summers of 1953 and 1954. The average duration of the disease was two months.

Dr. A. Piffaretti (Lausanne) found 1,233 ocular malformations among the 51,000 patients examined at the university eye clinic of Lausanne in the previous 14 years.

Dr. M. Favre (Berne) noted that posterior detachment of the vitreous occurs far more frequently without than with collapse of the vitreous. The aged and myopic are especially susceptible. A retinal tear may finally ensue.

Clinical studies

Dr. B. Cagianut (Zurich) observed two patients with a Kayser-Fleischer ring. In one of these examination of the eyes after death revealed the probable presence of silver and a trace of copper. During life the neurologic signs had regressed somewhat with BAL therapy.

Dr. H. Koenig and Dr. F. Marty (Geneva) confirmed the experience of Grant in the successful treatment of three cases having calcareous deposits in the cornea. In a patient with band-shaped keratopathy in which disodium versenate was used the visual acuity improved from 20/70 to 20/20.

Dr. A. Bangerter (St. Gall) utilizes an instrument of his own design for the precise stimulation of the macula in amblyopic eyes having eccentric fixation with good results. In paralytic strabismus in which spontaneous regression has failed to occur he finds that the combination of surgery and orthoptic training successfully achieves binocular vision without diplopia in the field of vision habitually used.

Dr. R. M. Steiger and Dr. A. Wurth (Zurich) have adapted the fundus camera to the examination of infants and by this means can decide whether macular fixation is possible or not.

Dr. P. Dieterle and Dr. J. Babel (Geneva) suggest that the simultaneous use of the electroretinogram and the electroencephalogram can aid in appraising the function of the visual pathway.

Dr. T. Schmidt (Berne) finds that in changes of fundus level produced pathologically the acuity may be corrected providing the retina is intact but that quantitative perimetry with white objects will reveal a relative scotoma in the affected area.

EXPERIMENTAL INVESTIGATION

DR. J. BABEL AND DR. J. B. BOURQUIN (Geneva) studied the intracorneal transplantation of sclerotic fragments in animals. During an observation period of two years no increased transparency of the scleral tissue occurred and histologic examination showed that the scleral structure remained unmodified.

DR. G. BOHME AND A. BANGERTER (St. Gall), who reported last year the successful treatment of retinal detachment arising from a hole in the macula with the placement of a fragment of placenta against the posterior pole, have since repeated the procedure on rabbits, using amnion. They find that the implant rests in the place set and provokes an intense localized cellular reaction lasting for a month. They conclude that for the closure of a macular hole this procedure is both most effective and least disturbing.

DR. H. R. ROHRINGER AND DR. F. SCHELLING (Zurich) confirmed the reduction of the ascorbic-acid content of the aqueous after induced ocular inflammation.

DR. A. HUBER (Zurich) compared the study of the aqueous by biomicroscopy in vivo with the examination of removed aqueous by ultramicroscopy and by phase-contrast microscopy. Only by the latter methods can the cell composition be determined and leukocytes, lymphocytes, and reticuloendothelial cells identified.

DR. M. AMSLER AND DR. A. HUBER (Zurich) have measured for the past nine years the rapidity and intensity of fluorescein in the anterior chamber after an intravenous injection of the dye. They are fully convinced of the clinical value of the test.

DR. E. B. STREIFF (Lausanne) reports that, in rabbits sensitized to uveal tissue, the induction of ophthalmia phacoanaphylactica does not provoke the reactions of sympathetic ophthalmia.

SURGERY

DR. G. WEHNER, DR. H. R. BOHRINGER AND F. KOENIG (Zurich) compared the Elliot trephining operation with iridencleisis in patients observed for over three years and found that both procedures gave a similar functional result from the long-range viewpoint. They consider that retrociliary diathermy is suitable as a supplementary operation and as an initial intervention when the initial tension does not exceed 40 mm. Hg.

DR. G. SAUBERMANN (Basle) details his results with the Ridley operation on four patients. All reacted with a severe postoperative iridocyclitis, fibrinous exudate, and posterior synechias, but none developed secondary glaucoma or subluxation of the lenticulus in the 18 months of observation. Postoperative irritation lasts four to eight weeks. By the third month, normal acuity was obtained in three patients with a slight correction. In the fourth case a persisting occlusio pupillae reduced vision permanently to an unimprovable 20/200.

John D. Blum (Geneva),
Correspondent.

James E. Lebensohn,
Translator.

OPHTHALMIC RESEARCH

Department

EDITED BY FRANK W. NEWELL, M.D.

Abstracts of papers to be presented before the Southern Section of the Association for Research in Ophthalmology, Houston, Texas, November 14th.

ALBERT E. MEISENBACH, M.D., *Section Secretary*

Prevention of recurrent pterygium by prophylactic beta irradiation (Iliff and strontium Applicators): Report of 100 cases. Seymour B. Gostin, M.D., Veterans Administration Hospital, McKinney, Texas.

The high rate of recurrence of pterygium despite the introduction of numerous variations in surgical technique has necessitated the exploitation of other modalities in the search for a solution to this problem. Two series of cases were treated prophylactically postoperatively with the Iliff and the strontium applicators with marked reduction in the recurrence rate. Experience with the Iliff applicator forces the conclusion that the earlier recommended dosage schedules were much too high. Recent reports suggest that present recommended strontium dosage is also too high.

Tissue culture of the human eye. C. M. Pomerat, Ph.D., University of Texas Medical Branch, Galveston, Texas, Professor of Cytology, Director of the Tissue Culture Laboratory.

Fetal, newborn, and adult human eye tissues have been successfully cultivated in roller tubes for the identification of cell types.

Among other observations, phase-contrast, time-lapse cinematographic records reveal marked pinocytois and mitochondrial activity in marginal cells from sheets of conjunctival epithelium, mitotic activity in spindle-shaped elements from Tenon's capsule, and phagocytosis by cells of microglial type from the retina.

Such techniques are particularly useful for direct observations on pathologic cell types, the effect of various nutrients, infectious agents, and drugs. The studies indicate that balanced salt solutions, such as those proposed by Gey, Earle, and Hanks, are less damaging to eye tissue than so-called "normal" saline.

The effect of chick-embryo extract on growth of whole cornea explants. Robert A. Hoagland, M.S., Research Associate, Department of Ophthalmology, Tulane University School of Medicine, New Orleans, Louisiana, and Gail S. Ford.

Although there is general agreement that tissue extracts are necessary for prolonged cultivation and maintenance of cells in tissue culture, there is little agreement as to the optimum concentration. Therefore, a study was undertaken to determine the optimum concentration of embryo extract in combination with 40-percent horse serum and Earle's balanced salt solution. The data indicate that under these circumstances 20-percent concentration of embryo extract gives the most uniform initiation, stimulation, and maintenance of growth of whole corneal tissues.

Properties of the water-soluble proteins of rabbit cornea. Marion A. Guidry, Ph.D., James H. Allen, M.D., and Joyce B. Kelly, Department of Ophthalmology, Tulane University, School of Medicine, New Orleans, Louisiana.

Extracts of rabbit cornea were prepared by mincing the tissue in phosphate buffer of pH 7.0 (Miller, G. L., Arch. Biochem., 29:420, 1950). The resulting extracts were not concentrated enough for satisfactory ultracentrifugal analysis and were therefore concentrated by ammonium-sulfate precipitation.

The concentrated extracts were analyzed ultracentrifugally using the Spinco Model E analytical ultracentrifuge. The extracts were found to contain three protein fractions which were called fractions I (lightest), II (intermediate), and III (heaviest). The sedimentation constants (uncorrected) for extracts from fresh tissue were found to be as follows: I = 3.2×10^{-13}s, II = 3.9×10^{-13}s and III 5.9×10^{-13}s. Extracts made from rabbit corneas which had been stored in the frozen state for several months also yielded solutions which contained three protein fractions. These sedimentation constants did not significantly differ from those for fresh rabbit corneas.

The sedimentation constants (for soluble rabbit corneal proteins) were compared to those obtained for soluble beef corneal proteins (unpublished data). Beef corneal extracts also show three fractions but the constants were as follows: I = 3.6 (10^{-13}), II = 6.3 (10^{-13}), and III = 16.6 (10^{-13}) s (uncorrected).

The relative concentrations of the three rabbit fractions based on area measurements of the schlieren patterns were found to be as follows: I = 51 percent, II = 21 percent, and III = 26 percent. The concentration ratios were unaffected by freezing the corneas before extraction.

A study of various types of eye injuries. K. W. Cosgrove, M.D., J. F. Henry, Jr., M.D., and R. G. Stevensen, M.D., Department of Ophthalmology, University of Arkansas Medical School, Little Rock.

A study was made of 16,306 eye examinations from the records of the Department of Public Welfare of Arkansas. These records covered the period from 1937 to 1954, inclusive. Eye injuries of a moderate to severe degree were recorded in 1,717 cases.

The various types of injuries were studied with relation to age, sex, and race. Injuries were found more frequently in the male than in the female, probably due to greater exposure. Persons under 40 years of age were more often injured, with the greatest number in the one- to nine-year age group. BB shot and fireworks injuries were equally divided between the one to nine and the 10- to 19-year age groups. Injuries from blows and falls were more frequent in persons over 40 years of age.

Cross tabulations were done showing the relationship of the type of injury to the site of the lesion, the activity engaged in when injured, and the resulting visual loss. Sharp objects usually damaged the cornea or iris. Blows and falls more often injured the lens or posterior part of the eye. Play or sport, occupational, and household activities, in order of decreasing frequency, were the most common activities related to the injuries. Chemical and heat burns were more frequent in household activities. Injuries to one eye only were seven times as common as injuries to both eyes. However there were equal numbers of injuries from firearms, explosions, chemical, and heat burns in one and both eyes. Visual acuity of 20/200 or less resulted in 100 percent of the cases from BB shot injuries, and in over 90 percent of

the cases of injuries from firearms, explosions, and sharp objects; 86 percent of the total cases resulted in blindness.

Bacteriologic studies of keratitis. Mary L. Sigtenhorst and Wendell D. Gingrich, Department of Ophthalmology, University of Texas Medical School, Galveston, Texas.

In nonulcerative keratitis, the bacterial flora of the lower conjunctiva was similar to that found in conjunctivitis. Micrococcus pyogenes var. aureus (coagulase postive) and Pneumococcus were the predominating isolations. Cultures obtained from cases of keratitis secondary to exposure or trauma frequently yielded a mixture of bacteria, many of which are considered to be nonpathogenic bacteria of the upper respiratory tract. In some instances of chronic or recurrent keratitis, little, if any, growth was obtained. In these cases the flora was usually regarded as that normally encountered on the lower conjunctiva.

In central corneal ulcer Pseudomonas was isolated much more frequently than in the nonulcerative keratitis. In several instances the corneal ulceration and Pseudomonas infection were secondary to systemic disease or another infectious process of the eye.

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FIFTH PAN-AMERICAN CONGRESS

The fifth Pan-American Congress of Ophthalmology will be held in Santiago, Chile, January 9 to 14, 1956. The congress is the regular quadrennial meeting of the Pan-American Association of Ophthalmology. This organization has for its aims the fostering of the progress of ophthalmology and related sciences; the establishing of contacts of social and scientific character among the ophthalmologists of the Western Hemisphere; the maintaining of the highest state of ethics among its members; and the instituting and promoting among the nations and peoples of the Western Hemisphere measures to conserve eyesight and to prevent

blindness. The pursuit of these goals is achieved in two ways: one, unique in the history of international organizations of ophthalmology, by maintaining an active, dues-paying membership between congresses; and two, by holding congresses every four years and interim meetings between congresses.

The first, organizing congress was held in 1940 in Cleveland, Ohio. Subsequent congresses under the presidency of Dr. Harry S. Gradle, were held in Montevideo, Uruguay, and Havana, Cuba. The fourth congress, under the presidency of Dr. Conrad Berens, was held in Mexico City. Dr. Moacyr Alvaro will preside at the fifth congress.

Anyone who has attended any of these meetings knows that they are not only superior from a scientific standpoint but that they are very pleasant social affairs as well. One has only to mention the magnificent fiesta in Havana or the television review of the folk dances in Mexico to recall the pleasure of those occasions. It is certain that our Chilean colleagues will plan something just as pleasant.

Plans for the scientific program are well advanced. The official subjects of the meeting will be discussed in a series of symposia which should be unusually rewarding. There will be simultaneous translation in two of the three official languages of the organization. Spanish and Portuguese will be translated into English and English will be translated into Spanish. It is noteworthy that the same system which will be used in Santiago was very successfully used for the first time at any medical meeting, at the interim meeting of the Pan-American Association of Ophthalmology held in São Paulo, Brazil, in June, 1954.

It is worthwhile to point out that this occasion presents a fine time to see South America. The official travel agent for the congress, Mr. E. F. Noonan, representing Journeys International of 6 East Monroe Street, Chicago, Illinois, has arranged a series of tours that include all the main points of interest in South America. In addition, Mr. Noonan has agreed to modify any itinerary to suit the individual taste. Furthermore, the Internal Revenue Department has given assurances that the transportation costs to and from the Congress, as well as expenses in Santiago while attending the Congress, are deductible items in computing one's income tax.

Inquiries concerning the program may be directed to Dr. James H. Allen, 1430 Tulane Avenue, New Orleans, Lousiana. Dr. J. Wesley McKinney, 921 Exchange Building, Memphis, Tennessee, is in charge of scientific exhibits, and Dr. H. Saul Sugar, 28 West Adams Street, Detroit 26, Michigan, is arranging for movies. Dr. Daniel Snydacker, 111 North Wabash Avenue, Chicago 2, Illinois, is the acting secretary-treasurer for North America during the illness of Dr. Thomas D. Allen and general inquiries may be directed to him.

Daniel Snydacker.

CATARACT EXTRACTION IN THE YOUNGER AGE GROUP

There is no question that, with the improvements in instrumentation, and anesthetic agents and their supplements, as well as more residency training programs, the results of cataract surgery are probably better today than they ever have been before. At least, more and more patients are being successfully taken care of in their local communities, and the complications encountered by the occasional but competent surgeon are decreasing in number.

With better anesthesia and akinesia, the intracapsular cataract extraction with or without a complete iridectomy is now the operation preferred by most ophthalmologists. In fact, there are some who believe that extraction by any other method is never indicated. Resident surgeons, in the enthusiasm of their first contact with surgery, frequently regard rupturing a capsule as serious a complication as loss of vitreous. This is because

they see the grayish-white pupillary space in an injected eye and forget that a planned extracapsular extraction is a much better procedure than that which results from unintentional rupture of the capsule. Unfortunately, many of them have never been exposed to a well-executed extracapsular extraction. When their chief operates and ruptures a capsule, he may deftly reach in, while his assistant irrigates the anterior chamber, and withdraw the remaining capsule with resultant removal of the capsule in toto, but, alas, when they execute the same maneuver that veritable large "bead" of vitreous presents.

Vail in his article on the "Zonule membrane and cataract expression" reviews the anatomy of the zonule and points out the relationship between the zonule, hyaloid, and lens. Anyone who has employed the sliding technique with a complete iridectomy has seen ample evidence of the zonular hyaloid adherence. In cases with a tough zonule, after the zonule has been ruptured above, a pull on the lens will produce a protrusion of the hyaloid into the lips of the wound. With release of this pull the hyaloid falls back. Delivery of the lens in these cases may take five to 10 minutes (by the clock). The zonule seems to separate fiber by fiber and the hyaloid to peel off the back of the lens. The presentation of the hyaloid during the procedure may be thought at first to be due to positive pressure, but following delivery of the lens the hyaloid can be seen to fall back and present a flat or, at times, a concave appearance. Even though no vitreous is lost, traction on the tough zonule may do unseen damage to the retina in the region of the ora serrata. The phenomenon decribed above is not seen when one uses the tumbling procedure, but may account for the occasional unexplained loss of vitreous in a soft eye when a technically satisfactory maneuver is being executed.

It is well known that it is difficult to assess the strength of the zonule before operation. There are some individuals of three score years and 10 who have surprisingly tough zonules. Then some of those much younger have a fairly fragile zonule. As a general rule, however, the younger the individual the tougher the zonule. The etiologic basis for cataracts in young people is usually congenital, traumatic, degenerative, and/or inflammatory. In the latter group, excluding frank uveitis, are those individuals who show peripheral retinal degenerative changes and whose first evidence of a cataract is a posterior subcapsular sheen suggesting a "cataracta complicata."

The treatment of congenital cataracts has for years been a discission followed by linear extraction if necessary. The methods described by Barkan and Cordes have in my hands been more satisfactory than a simple discission. Traumatic cataracts, especially those following an intraocular foreign body, are frequently associated with a disturbance of the vitreous and attempted removal in the capsule results in loss of vitreous. In the third category, intracapsular extraction is frequently attempted because it is considered the "ideal" operation or, because of the posterior subcapsular opacities, to avoid a subsequent discission of a secondary cataract.

I was brought up in the intracapsular school and have seen and helped with a fair amount of surgery in a large ophthalmic institution. The planned extracapsular procedure is not very frequently performed, but those who are adept at it and loosen the anterior capsule with a cystotome and then remove it with posterior tooth capsule forceps, followed by adequate drainage, seldom have to readmit their patients for a secondary discission.

The early disadvantages of the extracapsular extraction are: slow absorption of lens material with delayed use of the eye, phacoanaphylactica, and secondary glaucoma due to retention of cortical material. The late complications are poor transparency of the posterior capsule, formation of Elschnig pearls, and poor visibility of the peripheral fundus in case of a subsequent retinal detach-

ment. Most of these complications can be avoided with adequate removal of the anterior lens capsule and irrigation. The postoperative reaction to lens proteins can now be adequately controlled by the use of one of the corticosteroids.

This is not a plea to return to the extracapsular extraction but it is a suggestion that there is a time and a place for everything and that a well-executed extracapsular cataract extraction can at times be utilized to advantage. Those who do a large amount of surgery in teaching institutions might do well to instruct their residents in this procedure even though in their own hands an intracapsular extraction may be spectacular and successful. Residents completing their surgical training are highly skilled but most of them will be in practice five to 10 years before they have done as many operations as they did during their training. During this period of famine, they may be on their own in a general hospital with a nurse assistant and no coach at their elbow. They should know how to perform the extracapsular extraction satisfactorily, if it is indicated. One must never lose sight of the fact that the patient is being operated on to have his vision restored. Providing he can see, he is not particularly concerned with the shape of his pupil or the presence of a posterior capsule. One must weigh the advantages and disadvantages. The loss of viscid vitreous is a most serious complication and if the honest surgeon feels that it can be avoided by an extracapsular extraction he should be prepared to do it and not give as an excuse, following the loss of vitreous, "Well, it was a young patient and I particularly wanted an intracapsular extraction with a round pupil." It behooves us all to reflect on our abilities and do what is easiest for us and best for the patient.

P. Robb McDonald.

OPHTHALMOLOGY UNDER ATTACK*

During the last quarter of a century there have been, as everyone knows, great advances in applied science generally and medicine particularly. Together with these, and to some extent, as a result of them, certain legal, economic, and ethical complications have developed as people have learned to appreciate the tremendous influence upon economics which political power can exert. Thus, today, state legislatures and congress are battle-grounds in which pressure groups strive for political control for their own economic advantage.

Medicine has held aloof from this process and has sought no special preferment, and indeed, in general, has, by working for adequate control of disease, attempted to destroy the reason for its own existence. In recent years, however, this selfless viewpoint has been challenged by fringe groups who have attempted, without adequate medical education, to "muscle in" on the practice of medicine; this, of course, not with any idea of being of service to the public, but, basically, with the idea of sharing in the monetary rewards.

Ophthalmology, as one of the important medical specialties, has, until comparatively recent years, along with the rest of the medical world, been permitted to develop its field and services without limitation or interference by legislative bodies. This condition, however, no longer obtains because, at the present time, a well-organized effort is being made not only to limit ophthalmology in its field, but also to extend legally to other groups part of the traditional duties and privileges of the ophthalmologist. In this we have the first real attempt to limit medical science by legislative enactment, a proposal which must be resisted vigorously by ophthalmology in the interest of public health and well being.

* Reprinted from the *Transactions* of the Pennsylvania Academy of Ophthalmology and Otolaryngology, Directory Issue, Spring, 1955.

There is very good reason to believe that there is a nationwide and fairly well-organized program, supported by the American Optometric Association, as evidenced by the resolutions adopted at the last meeting of that organization, to attack ophthalmology in every state or, if direct attack is not feasible, to harass it by diversionary actions, such as the present attempt to eliminate or control dispensing optical work. The latter type of approach has succeeded in some states, particularly in New Jersey. In New Jersey, certain provisions of the Opticians' Licensing Law, included at the insistence of the optometric lobby, interfere with the practice of ophthalmology. In that state a campaign is also being waged to extend the present law, under which school districts may employ optometrists for ocular examinations, by making it mandatory to employ an optometrist in every school district and removing him from the jurisdiction of the School Medical Service.

In Pennsylvania, the Blind Pension Act provisions, which permit every optometrist in the state to certify as to the etiology, diagnosis, prognosis, and possibilities of treatment of the blind, and the visual acuity certificate provisions which have at present embroiled the Philadelphia School Medical Service in a controversy with the optometric groups desirous of diagnosing and treating ocular disease in school children, are good examples of the indirect approach to extension of the optometric field.

Leaders of this optometric drive for medical and surgical privileges through legislation and through the liberal interpretation of apparently innocuous legislative provisions have their sights set definitely upon obtaining legal permission to practice ocular medicine and surgery. This is apparent not only from the actual resolutions, which have been approved by the state and national optometric societies, but is also apparent from their actions. The control of dispensing optical work has been attempted in a number of states and has actually been successful in several of them. This is a step, of course, in the direction of embarrassing ophthalmology by controlling the dispenser, who is really an adjunct to ophthalmology and who should be, generally speaking, under ophthalmologic guidance.

A more direct type of interference has been that of legislative proposals to deny the field of refraction work to the ophthalmologist and to extend the optometric field into ocular medicine and surgery. While proposals of the first type have been actually introduced into some of the state legislatures, none as yet have been enacted, but it is conceivable that, if there is no organized opposition by the ophthalmologists, such legislation could be passed and become the law in many states.

As long ago as 1935 an attempt was made in Pennsylvania to obtain legal permission for every registered optometrist in the state to practice what was termed "limited ocular medicine and surgery." This was defeated with some difficulty, as our older ophthalmologists will recall, especially those who made the trip to Harrisburg to testify before the legislative committee. Recently the optometrists apparently have decided that the times are now propitious for another and more determined effort. For example, within the last few weeks, there have been introduced into the Missouri and Oklahoma legislatures amendments to the Optometry Acts which would permit any licensed optometrist to diagnose and treat ocular disease. The optometric leaders in these states, while somewhat premature in their actions, are carrying out the mandate of their national organization and similar legislative attempts can be expected sooner or later in all states, especially in Pennsylvania and New Jersey.

Not all of the licensed optmetrists in each state are in favor of these attempts to invade medical practice. Indeed, perhaps a majority still consider themselves as merchants and are quite content to be let alone to sell glasses. This group, however, has no influence in organized optometry and are not

consulted regarding its program.

Legislative proposals, if they are to be considered seriously by the various legislatures, must be properly financed, and this question of raising enough funds for the purpose has been one of the major difficulties faced by the ambitious optometric groups. In several states, a new and apparently effective method of raising the necessary funds for attacking the ophthalmologists and opticians and for providing increased privileges for themselves has been worked out in what may be regarded as a somewhat questionable manner. This is to set up a dummy organization, ostensibly devoted to the conservation of vision, but actually representing a source of funds for legislative and legal expenses to be financed by an assessment of the wholesale optical houses, amounting to one percent or more of the monthly material bills paid by each optometrist, optician, and ophthalmologist, an assessment forced by the threat of boycott of noncontributors. This black-mailing type of fund collection is already in operation to a certain extent in Pennsylvania and threatens to become universal not only in our state, but in all others. If carried out, as its proponents hope that it can be, it will provide a considerable war chest amounting, in the opinion of one individual who is in a postion to know, to probably $150,000 yearly in Pennsylvania. It is somewhat ironic to observe the dispensing opticians, and the ophthalmologists who do some dispensing, contributing indirectly to the political funds of their bitter enemies. Of course, it remains to be seen what the United States Department of Justice will do in this matter when it is called to their attention. It is possible that some of those involved will find themselves in jail.

Space does not permit a full list of these nationwide attempts to gain undeserved preferment. Those cited above are some which are of immediate interest to Pennsylvania ophthalmology.

The Legislative and Conservation of Vision Committees of the Pennsylvania Academy of Ophthalmology and Otolaryngology are fully aware of the situation, as is the New Jersey Ophthalmological Society and some other ophthalmologic groups. This awareness, however, does not extend to many of the ophthalmologists in those states and even less to those in many other states where direct attacks have not yet been made. Fortunately, however, the matter is coming to the attention of the leaders of national ophthalomology, and publicity and organization at the national level may be expected shortly.

Meanwhile, inasmuch as the matter is so vital to the continued freedom of ophthalmology which, in turn, is essential for the well being of the public, every ophthalmologist in Pennsylvania should make it his business to be acquainted with the situation and to be ready to share in the defense of his privileges and duties.

EDWIN F. TAIT.

CORRESPONDENCE

LEAFLET ON RETROLENTAL FIBROPLASIA

Editor,
American Journal of Ophthalmology:

The "Symposium on retrolental fibroplasia" in the August issue of THE AMERICAN JOURNAL OF OPHTHALMOLOGY was very well presented. (Thanks, Ed.)

In Dr. Blodi's paper on page 186, he mentioned that some of the members of the symposium had prepared a leaflet for parents. It was not mentioned where the leaflet might be obtained. At the request of the executive secretary-treasurer of the American Academy, the National Society for the Prevention of Blindness printed the leaflet. If readers of THE AMERICAN JOURNAL OF OPHTHALMOLOGY would like copies for the parents of children under their care, we shall be glad to supply them. (National Society for the Pre-

vention of Blindness, 1790 Broadway, New York 19, New York.)

(Signed) Franklin M. Foote, M.D.,
Executive Director.

PERVERTED ORTHOGRAPHY

Editor,
American Journal of Ophthalmology:

For a long time I have been looking and listening in horrified silence, watching that poor inoffensive word "districhiasis" getting kicked around. I had almost become resigned to "districhiasis." But I was finally forced to take my pen in hand when an honored contemporary of THE JOURNAL, who shall be nameless, recently mangled that wretched word and made it come out—so help me!—"dystrichiasis" (issue of January, 1955, page 121, right hand column, line 31, first word). You must admit that this is a really distinguished example of perverted orthography which must not go unchallenged.

Apparently even among our most illustrious colleagues there is a tendency to relate "distichiasis" to "trichiasis" when actually there is no such connection. True, both refer to the lashes and both are derived from Greek roots. But there all similarity ends: "Trichiasis" is derived from the Greek θρίξ (thrix) meaning a hair. "Distichiasis" is derived from the Greek δί (di) meaning two and στίχος (stichos) meaning a row, hence two rows of lashes. Obviously there is not the slightest etymological consanguinity between these two—not even under a left-handed bar sinister.

I realize that mine is a lone voice crying in the wilderness and I know that nothing will save "distichiasis" from the chaos of utter confusion which has already engulfed such words as "hemeralopia" and "nyctalopia," "homograft" and "isograft," "intraocular pressure" and "intraocular tension," and so forth.

But I had to try.

(Signed) Sydney A. Fox,
New York.

BOOK REVIEWS*

EVALUATION OF ADJUSTMENT TO BLINDNESS. By Edward A. Fitting. New York, American Foundation for the Blind, 1954. Paperbound, 84 pages, bibliography. Price: $1.00.

This study is the first product of the Research Fellowships sponsored by the American Foundation for the Blind. Rehabilitation services in this country are the outgrowth of increased public consciousness of the need for such service as the result of two world wars. The success achieved in veterans' centers resulted in the establishment of a number of civilian adjustment centers. The first rehabilitation center for the blind, St. Dunstan's, was organized in England by Sir Arthur Pearson for the casualties of World War I and the famous center continued to render like service for the victims of World War II under the direction of Sir Ian Fraser. Similar programs in this country were influenced by this institution. In the United States the incidence of the visually disabled appears to be increasing. The first adjustment center, established in North Carolina, produced an outstanding record of job placement. Severe visual disability is not associated with severe personality disturbance in the overwhelming proportion of persons studied. "The well-adjusted blind person recognizes that his physical disability imposes certain vocational limitations but, at the same time, he does not excuse mediocre performance on the basis that special concessions must be made to him because of his disability."

RESOURCES FOR TEACHERS OF BLIND WITH SIGHTED CHILDREN. By Georgie L. Abel. American Foundation for the Blind, New York, 1954. Paperbound, 58 pages, bibliography. Price: $0.75.

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* The six publications here reviewed are available at the prices listed from the American Foundation for the Blind, 15 West 16th Street, New York 11, New York.

This compilation catalogues the materials needed in implementing a program for the education of the blind and partially blind with sighted children, and gives detailed suggestions for the best use of the equipment. The Talking Book reproducer should be equipped with headphones so that the children can work independently without disturbing others. The Braille books should be stored upright as stacking them might damage the Braille dots. For those with a visual acuity of 10/200 or better, the available magnifying and projection devices are listed. An eight-power prismascope which aids in the identification of street signs and busses and can be used at the theater is sold directly to the afflicted by Du Maurier Company, Elmira, New York, for $9.95.

THE PINE BROOK REPORT: NATIONAL WORK SESSION ON THE EDUCATION OF THE BLIND WITH THE SIGHTED. New York, American Foundation for the Blind, 1954. Paperbound, 72 pages. Price: $0.90.

The advent of retrolental fibroplasia as the major cause of blindness among children of school age has extended greatly the education of the blind with the sighted within the past five years due to the insistent efforts of parents to keep their beloved blind children in the family life. The diverse patterns of this type of education utilize in varying measure the services of a qualified teacher of blind children. The blind child, consistent with his training, spends an appropriate part of his school day with sighted children. The everyday companionship with sighted classmates promotes the future development of a healthy maturity.

A SWIMMING PROGRAM FOR BLIND CHILDREN. By Robert Belenky. New York, American Foundation for the Blind, 1955. Paperbound, 44 pages. Price: $0.45.

This thorough and well-planned guide for teaching swimming to sightless students is based on the author's personal experience. Swimming both affords enjoyment and promotes constructive body development. It is consequently taught to some extent in most schools and camps for the blind.

A STUDY OF THE LIVING EXPENSES OF BLIND PERSONS. By Nathaniel J. Raskin. New York, American Foundation for the Blind, 1955. Paperbound, 44 pages. Price: $0.50.

The expenditures of the blind are compared with the sighted at various economic levels. In the low-income group the blind spend relatively more for food and housing, less for transportation, apparel, and medical care. At higher income levels these differences disappear except for a greater expenditure by the blind for medical care.

VOCATIONAL COUNSELING OF BLIND STUDENTS. By Nathaniel J. Raskin. New York, American Foundation for the Blind, 1955. Paperbound, 24 pages. Price $0.30.

A counseling program is essential at the secondary school level. This investigation shows that almost twice as many students were being counseled in 1953 than five years previously and that the 1953 students were given more detailed tests on intelligence, dexterity, interest, and personality. The schools are now providing vocational information more systemically and in greater quantity.

James E. Lebensohn.

ABSTRACT DEPARTMENT

EDITED BY DR. F. HERBERT HAESSLER

Abstracts are classified under the divisions listed below. It must be remembered that any given paper may belong to several divisions of ophthalmology, although here it is mentioned only in one. Not all of the headings will necessarily be found in any one issue of the Journal.

CLASSIFICATION

1. Anatomy, embryology, and comparative ophthalmology
2. General pathology, bacteriology, immunology
3. Vegetative physiology, biochemistry, pharmacology, toxicology
4. Physiologic optics, refraction, color vision
5. Diagnosis and therapy
6. Ocular motility
7. Conjunctiva, cornea, sclera
8. Uvea, sympathetic disease, aqueous
9. Glaucoma and ocular tension
10. Crystalline lens
11. Retina and vitreous
12. Optic nerve and chiasm
13. Neuro-ophthalmology
14. Eyeball, orbit, sinuses
15. Eyelids, lacrimal apparatus
16. Tumors
17. Injuries
18. Systemic disease and parasites
19. Congenital deformities, heredity
20. Hygiene, sociology, education, and history

7

CONJUNCTIVA, CORNEA, SCLERA

Alcala Lopez, Antonio. **Evolution of the treatment of serpigenous corneal ulcer.** Arch. Soc. oftal. hispano-am. **15**:295-305, March, 1955.

After a historical review of the therapy of serpigenous ulcer, the author describes his pattern of treatment. It begins with exploration of the lacrimal sac and its excision, if that is found to be indicated. One million units of penicillin is administered intramuscularly in the course of three days. The ulcer is curetted and cauterized with iodine or trichloracetic acid. Atropine, aureomycin, and noviform and dionin ointments are applied every two hours, while the patient is awake. Under this treatment the ulcer is usually epithelized within a week. The noviform-dionin ointment is continued for two to four months to diminish the resulting opacity. Cortisone ointment is applied after healing is complete, in about a month.

Ray K. Daily.

Browning, C. W., and Lippas, J. **pHisoHex keratitis.** A.M.A. Arch. Ophth. **53**: 817-824, June, 1955.

Two cases of deep keratitis were noted in man following chance introduction of "pHisoHex" into a normal eye during preoperative preparation for ocular surgery. A similar keratitis was produced in experimental animals. The component chemical responsible for the keratitis is trinitrotoluene. (7 figures) G. S. Tyner.

D'Ermo, F. **Recent adjuncts in the treatment of burns of the cornea and conjunctiva.** Boll. d'ocul. **34**:232-242, April, 1955.

The author reviews the more recent therapeutic agents that have been found effective in the treatment of burns of the cornea and conjunctiva. A treatment of ocular burns is outlined by the author as follows: 1. general treatment, lavage of the injured tissues with weakly antiseptic solutions, and 2. treatment with specific antidotes: B.A.L. in Lewisite burns; antidotes for lime and for acids, 3. nonspecific treatment: cortisone, antihistaminics, sulfhydryl, 4. treatment with vasodilators locally, and 5. treatment with antibiotics. (42 references) William C. Caccamise.

Greaves, D. P. **Experimental penetrating keratoplasty.** Tr. Ophth. Soc. U. Kingdom **74**:135-144, 1954.

The author shows that for the maintenance of a clear cornea it is important to control infection and to attain good opposition, which minimizes the formation of anterior synechiae and the proliferation of vessels. His experimental work was greatly aided by the use of heparin, a mechanical trephine, an acrylic corneal cap, and antibiotics. (5 figures, 3 tables, 15 references) Beulah Cushman.

Günther, Gregory. **A contribution to the morphology of Groenouw's corneal dystrophy.** Klin. Monatsbl. f. Augenh. **126**:568-575, 1955.

A 40-year-old woman with a typical granular dystrophy had a successful keratoplasty. The histologic examination revealed the well known picture of epithelial proliferation, defects in Bowman's membrane and granular deposits. These deposits are eosinophilic and of a protein-like nature. The staining properties of these deposits are similar to paramyloid. (7 figures, 15 references)
Frederick C. Blodi.

Kolesnikova, G. J. **Rare form of corneal vernal catarrh.** Vestnik Oftalmologii **33**: 36-38, 1954.

Vernal catarrh in a boy, 14 years of age, affecting both corneas, is described. Characteristic pavement-like elevations were seen on the conjunctiva of the lids and the same type of flat growth covered all but the central third of the cornea. X-ray treatment resulted in a fairly clear cornea. In the right eye, after removal of the growth and of superficial layers of the cornea, a thin transplant was used. Healing was successful and the visual acuity was improved (0.5 with correction).
Sylvan Brandon.

Laval, J., and Lloyd, R. I. **Successful corneal transplants in four eyes of two patients with lattice dystrophy.** A.M.A. Arch. Ophth. **53**:884-888, June, 1955.

Four grafts have remained clear for four years in eyes with lattice dystrophy. (11 figures, 11 references) G. S. Tyner.

Marin Amat, M. **The Treatment of dendritic keratitis.** Arch. Soc. oftal. hispano-am. **15**:206-219, Feb., 1955.

This is a comprehensive review of the literature on herpes simplex of the cornea. An original feature is the author's technique of cauterizing the ulcer with tincture of iodine. To eliminate the pain of the procedure he anesthetizes the ulcer with crystals after preliminary instillation of a 4-percent solution of cocaine. This anesthetizes the cornea profoundly and permits thorough cauterization of the ulcer with tincture of iodine. The applications of the cocaine crystals and the iodine are made with a glass rod and are repeated every four or five days. Three cases illustrating the efficacy of the procedure are reported. Ray K. Daily.

Mezquita, P., Rabadan, P., Amerigo, A., and Osorio, J. **The treatment of trachoma with aureomycin and terramycin.** Arch. Soc. oftal. hispano-am. **15**:136-152, Feb., 1955.

The authors treated 174 cases of trachoma, in a region where the disease is endemic trachoma, with aureomycin and terramycin, in the form of an ointment applied locally. Of these treated with aureomycin 38.3 percent were cured, and those treated with terramycin 46.8 percent were cured. In 70 cases the drug used and the time required for a cure are briefly reported. The literature is reviewed. (1 table) Ray K. Daily.

8

UVEA, SYMPATHETIC DISEASE, AQUEOUS

Rohrschneider, W. **Typical and atypical uveal tuberculosis.** Klin. Monatsbl. f. Augenh. **126**:529-534, 1955.

Those cases in which the diagnosis is only clinical and presumptive are considered atypical. It usually starts between the thirtieth and fortieth year and is bilateral. 180 cases of proven uveal tuberculosis were collected from the literature. Most of the patients were adolescents or young adults. 20 percent of the patients died of tuberculosis. In 18 patients both eyes were affected; this form is a true metastatic infection. (3 figures, 9 references) Frederick C. Blodi.

9

GLAUCOMA AND OCULAR TENSION

Hobbs, H. E. **Gonioscopy after glaucoma operations.** Tr. Ophth. Soc. U. Kingdom **74**:153-170, 1954.

The author reviewed the gonioscopic findings in patients who had different types of filtrating operations for glaucoma. He found that the trephine operation has stayed the course of the disease for many years and that its complications lend themselves more readily to observation. (16 figures, 3 references)

Beulah Cushman.

Millan Hernandez, D. Jose. **The medical treatment of glaucoma. The rationale and technique.** Arch. Soc. oftal. hispano-am. **15**:153-179, Feb., 1955.

This prize essay, in a contest sponsored by Laboratories del Norte de Espagna, is a review of the literature. (3 figures, 48 references) Ray K. Daily.

Moreu Gonzalez-Pola, A., Sanchez Salorio, M., and Garcia Lopez, R. **Diamox in ocular tension.** Arch. Soc. oftal. hispano-am. **15**:306-308, March, 1955.

This is a preliminary note on a study on the effect of diamox on the ocular tension. Diamox was found to have a hypotensive effect in all cases of ocular hypertension, although its effectiveness varies widely in the different forms. It is very effective in post-traumatic hypertension and in acute glaucoma. In simple glaucoma the degree of reduction in tension varies widely; it seems to be related to the resistance to aqueous outflow.

Ray K. Daily.

Ricci, L. **Outflow determinations in glaucoma.** Boll. d'ocul. **34**:225-231, April, 1955.

Intraocular tension is in great part the result of a relationship between the production and the elimination of aqueous.

Using a tonographic method described by Blaxter (application of a tonometer to the cornea for four minutes while pressure is applied sclerally near the insertion of the external rectus muscle with a Baillart ophthalmodynamometer), the author determined the outflow index in various forms of glaucoma. The outflow index was also determined after various surgical procedures for glaucoma. The highest postoperative outflow rate was obtained after iridencleisis. The lowest postoperative outflow rate was obtained after cyclodiathermy. (1 table)

William C. Caccamise.

Scheie, H. G., Frayer, W. C., and Spencer, R. W. **Cyclodiathermy.** A.M.A. Arch. Ophth. **53**:839-846, June, 1955.

Follow-up results including tonographic studies are presented on 38 eyes with glaucoma treated by means of cyclodiathermy. The technique of Reiser and Castroviejo was employed. This consists of 8 to 10 applications of a 1 or 1.5 mm. electrode 6 mm. behind the limbus over slightly more than ½ the circumference of the globe. The electrode is applied for ten seconds.

The ocular tension was controlled in 15 eyes by cyclodiathermy alone. In six more it was controlled by the additional use of miotics; in 17 eyes the treatment failed. The procedure was least effective in infantile glaucoma. When successful it acts by

decreasing aqueous flow into the eye. (1 figure, 3 tables, 19 references)

G. S. Tyner.

Schmerl, Ernst. **Brightness stimuli and the diencephalon.** Klin. Monatsbl. f. Augenh. **126**:598-607, 1955.

The author assembles further experimental data for his hypothesis that light and smell stimuli influence the intraocular pressure. These stimuli reach the vasomotor center of the hypothalamus and from here vasoconstrictors and dilators reach the eye.

Two groups of 25 persons were tested. Every patient had two tonometric readings at 15 minute intervals. One group had to smell l-citronell between the two tonometries. This substance has a certain brightness value, according to experiments on rabbits. In the control series the intraocular pressure remained constant. In the second group the pressure decreased by an average of 3 mm. The decrease was more marked in patients with glaucoma. It was also present in four patients with anosmia. Only one person experienced an increase in intraocular pressure. (3 figures, 2 tables, 29 references)

Frederick C. Blodi.

Stagni, S. **Variation in the permeability of the blood-aqueous barrier after iridencleisis.** Boll. d'ocul. **34**:307-314, May, 1955.

The author first reviews the literature concerning results with the fluorescein test of Amsler and Huber. As a preliminary to his study of glaucomatous eyes he examined 10 patients (20 eyes) who were free of eye disease and thus determined the so-called normal zone. In these normal eyes the fluorescein appeared in the anterior chamber within two to four minutes. In glaucomatous eyes (12) that had not been subjected to surgery the fluorescein appeared in about the same time. In those eyes (6) that had had an iridencleisis procedure the fluorescein appeared earlier—within one-half to two minutes. In addition, the fluorescein rate between the tenth and the twenty-fifth minute was also higher in the eyes which had been operated upon. This indicates an increased permeability of the blood-aqueous barrier after iridencleisis. (1 diagram, 10 references)

William C. Caccamise.

Takats, E. **A case of glaucoma requiring seven operations in one eye.** Ophthalmologica **129**:202-205, March, 1955.

A 59-year-old man presented himself with a chronic, mildly congestive glaucoma, almost absolute in one eye and fairly early in the other eye. During a period of approximately five years five cyclodialyses and one basal iridectomy were performed to control the ocular tension. Finally, a cataract extraction improved the visual acuity to 20/40 without interfering with the tension-normalizing effect of the last cylodialysis. (3 figures)

Peter C. Kronfeld.

10

CRYSTALLINE LENS

Fernandez-Repeto, Santiago. **Crystalline cataract.** Arch. Soc. oftal. hispano-am. **15**:289-291, March, 1955.

The author reports crystals in the nuclei of the lenses in two sisters. There was no elevation of the cholesterol content of the blood. The literature is briefly reviewed. In these patients the deposit is attributed to an intrauterine dystrophy caused by a metabolic disturbance before the fourth month of pregnancy. (8 figures)

Ray K. Daily.

Friedenwald, J. S., and Rytel, D. **Contribution to the histopathology of cataract.** A.M.A. Arch. Ophth. **53**:825-831, June, 1955.

In experimental cataract formation in laboratory animals, the earliest morpho-

logic change in the lens cortex was hydrops of the lens fiber. This was almost simultaneous with the appearance of vacuoles visible ophthalmoscopically. (18 figures, 7 references) G. S. Tyner.

Glover, E. C. **The results of cataract extractions performed at Moorfields in 1949.** Tr. Ophth. Soc. U. Kingdom. **74**:145-151, 1954.

The author studied the 949 operations which were done in 1949 by 22 surgeons (12 staff members and 10 residents). There was little difference between the visual results of intra- and extracapsular cataract extraction. Apart from retinal detachment, complications were rather more common after extracapsular extraction. In the presence of complicating factors, particularly myopia, the intracapsular method is the operation of choice.

Beulah Cushman.

Gourlay, J. S. **Shagreen in cataract surgery.** Tr. Ophth. Soc. U. Kingdom **74**:131-138, 1954.

The author found that a good shagreen is a reliable sign that the lens capsule can be readily grasped and an intracapsular lens extraction more easily done.

Beulah Cushman.

Guillaumat, L., and Girard, G. **Visual results after operation for congenital cataracts.** Bull. et mém. Soc. franç. d'opht. **67**:343-356, 1954.

The case reports of 77 patients with congenital cataract from the ophthalmologic service of Quinze-vingts were analyzed; 56 patients had one, 98 had several operations. The visual results were poor inspite of satisfactory surgical techniques, mostly because of accompanying congenital malformations or some anomalies in the conduction of the stimuli. Zonular cataracts have a better prognosis than total nuclear cataracts. (4 tables)

Alice R. Deutsch.

Hope-Robertson, W. J. **One hundred cataract extractions with an erisophake.** Tr. Ophth. Soc. New Zealand pp. 12-28, 1954.

Several types of erisophake are discussed. The author's method of intracapsular extraction with round-pupil and sutures is presented. (18 figures, 16 references) Robert A. Moses.

Jacobs, Clyde H. **Pentothal sodium in 748 cataract extractions.** J. Internat. Coll. Surgeons **23**:769-776, June, 1955.

Sodium pentothal should be administered by a trained anesthetist. It is not without danger and should not be given to children or to patients with hepatic or nephritic disease. The complete relaxation of the eye makes the Graefe section more difficult, although the keratome incision works well in the softened eye. Laryngospasm occurs in five percent of cases. The addition of curare reduces the laryngospasm but increases respiratory depression. Nasal administration of oxygen reduces the amount of pentothal required. There were two deaths in the operating room. (29 references)

Irwin E. Gaynon.

Jordan, Martin. **A family with coralliform cataract.** Klin. Monatsbl. f. Augenh. **126**:469-475, 1955.

57 members of three generations could be examined and 24 had this type of lens opacity. The cataract was star shaped in the anterior or posterior cortex. It was a juvenile cataract which did not progress. The visual acuity remained between 5/7 and 5/35. (3 figures, 17 references)

Frederick C. Blodi.

Meisner, W. **The treatment of congenital lens luxations.** Klin. Monatsbl. f. Augenh. **126**:618-620, 1955.

The author performs repeated discissions with two needles. Four patients were successfully treated in this way.

Frederick C. Blodi.

Paufique, L. **Technique and complications of the Ridley operation.** Bull. et mém. Soc. franç. d'opht. **67**:378-385, 1954.

In 15 of 29 patients in whom Ridley lenticles had been inserted after extraction of cataract, the visual acuity was between 5/10-10/10. The Ridley lens became displaced in two patients and in one the vision could not be tested. Early complications included impossibility to place the lenticle correctly, postsurgical keratitis, postsurgical iritis and hyphema which only occurred once. Late complications were hypertension, occlusion of the pupil, malposition of the lenticle, luxation of the lenticle and secondary cataract. This operation is indicated only in monocular cataract on the supposition of making binocular vision possible. Details of surgical procedures and variations are discussed. Alice R. Deutsch.

Peret, Paulo. **Anterior lenticonus.** Rev. brasil. oftal. **14**:109-120, June, 1955.

The author reviews the literature on anterior lenticonus and briefly mentions the different etiopathogenic theories of origin which have been suggested. He briefly describes the diagnosis of this condition and describes a case observed by him, giving the exact refractive findings on this patient. (3 figures, 14 references) Walter Mayer.

Pillat, A. **The acute, disseminated, anterior subepithelial cataract after zinc cauterization of the cornea.** Klin. Monatsbl. f. Augenh. **126**:561-568, 1955.

These characteristic white lens opacities are usually found after an acute attack of glaucoma. However, a few cases have been observed after injuries (contusion) and alkali or other chemical burns. The author observed three such cataracts after cauterizing the cornea with a 20 percent zinc sulfate solution. They occurred as early as 12 days after the cauterization and none of the eyes ever had an increased intraocular pressure. It is therefore quite likely that not increased pressure but a chemical agent (histamine?) common to glaucoma, injury and chemical burn causes these lens opacities. (8 references) Frederick C. Blodi.

Sedan, J., and Farnarier, G. **Cataract operation after retinal detachment.** Bull. et mém. Soc. franç. d'opht. **67**:362-377, 1954.

The purpose of this paper was to clarify surgical indications in the presence of simultaneous old or fresh retinal detachment and cataract. In the presence of a retinal detachment and cataract the authors believe that the intracapsular cataract extraction should be performed first, to permit a more exact localization of the retinal tear. They perform the diathermy coagulation of the detachment 22 to 35 days after the combined intracapsular cataract extraction, a plan which was not approved by most of their colleagues who choose to do the detachment operation first, relying for the localization of the tear on the history of the start of the visual disturbances. Cataract extractions in surgically healed retinal detachment are generally favorable if the tension is normal, no uveal irritation is present and quantitative and qualitative light projection are normal. Nevertheless two eyes were lost, in spite of an uneventful course immediately after surgery. Cataract extractions in old or only partially reattached retinas always have a bad prognosis and the decision for surgery should be made by the patient after adequate instruction on the seriousness of the situation. A cataract extraction for cosmetic purposes only has to be considered occasionally. (7 references) Alice R. Deutsch.

Talbot, Graeme. **Modified McLean suture for cataract.** Tr. Ophth. Soc. New Zealand pp. 28-31, 1954.

The author uses three sutures preplaced radially across a limbal groove, with no conjunctival flap. (7 references)

Robert A. Moses.

Viallefont, and Boudet. **Cataract-operations after intraocular tuberculosis.** Bull. et mém. Soc. franç. d'opht. **67**:338-342, 1954.

Cataract extractions in eyes having had recurrent tuberculous uveitis may be successful. They should be performed when the eyes are quiet and after the necessary treatment has been given. Antigène méthylique in increasing doses was the medication of choice. Immediately before surgery streptomycin was started and continued until 28 to 30 gm. were given. Another series of Antigène méthylique followed the streptomycin injections. Tuberculin injections often are very effective but may precipitate the outbreak of metastatic lesions. Seven case histories are reviewed. Five of the seven patients were benefited by the cataract operation.

Alice R. Deutsch.

Wolfe, Otis R. **Traumatic cataract surgery in children.** J. Internat. Coll. Surgeons **23**:739-746, June, 1955.

In the conservation of vision it is important that surgery be performed early, while the retina still retains good function and before secondary glaucoma occurs or atrophy and softening set in. The author's double cannula suction and lavage for removal of the cortex is described. A sickle shaped knife for secondary membranous cataract is described for use when the straight Ziegler knife is inadequate (10 figures, 2 references) Irwin E. Gaynon.

Zolotnikova, S. J. **Magnetic foreign bodies in the lens.** Vestnik Oftalmologii **33**:22-27, 1954.

Revision of attitude toward intracrystalline foreign bodies is recommended. On the bases of 11 cases seen within the last two years the author suggests surgical removal of foreign bodies, if they are localized near the posterior or anterior surface of the lens. Foreign bodies may be left in the lens if they are in the area of the embryonic nucleus, where they have a tendency to be inert. In six cases where a conservative attitude was adopted the lens became cloudy in three and symptoms of siderosis appeared in two. In one case it seemed to the author that an abscess had formed around the foreign body. Good results were obtained in three cases where the foreign body was removed with the help of the magnet. In two cases where intranuclear localization was present a conservative attitude seemed to be justified.

Sylvan Brandon.

11

RETINA AND VITREOUS

Bedell, Arthur J. **The retinopathy of hypertension and pregnancy.** J. Internat. Coll. Surgeons **23**:763-768, June, 1955.

The physiologic variations of the retinal arteries and veins are many. One must understand the normal variations before classifying the abnormal. The blood pressure should be recorded with every fundus examination in patients with hypertension or retinopathy. Both copper and silver wire reflexes may be found in the same artery in long standing arterial disease. White irregular broad streaks on an artery wall are atheroma plaques. The most important sign of ocular damage in pregnancy is spasm in one or more arteries. If the spasms increase in number and attacks of blindness become more frequent, the pregnancy must be terminated.

Irwin E. Gaynon.

Doyle, A. E. **Retinal changes in hypertension.** Tr. Ophth. Soc. New Zealand pp. 39-42, 1954.

The retinal changes in hypertensive

vascular disease are discussed; the Keith-Wagener classification is used. (1 figure, 7 references) Robert A. Moses.

Engle, M. A., Baker, D. H., Baras, I., Freemond, A., Laupus, W. E., and Norton, E. W. **Oxygen administration and retrolental fibroplasia.** Am. J. Dis. Child. **39**:399-413, April, 1955.

Ninety-four premature infants were divided into two groups; one on restricted oxygen, and the other on larger oxygen dosage. Birth weights were from 800 to 1,650 grams. No significant difference was found in the incidence of retrolental fibroplasia between the two groups. The highest incidence occurred among children born at 29 to 30 weeks' gestation. It was noted that all infants in both groups resided in an oxygen-rich environment up to the assigned age. (23 tables, 22 references) Harry Horwich.

Fenwick, G. de L. **Retrolental fibroplasia.** Tr. Ophth. Soc. New Zealand pp. 32-38, 1954.

After a brief review of the clinical findings in retrolental fibroplasia, a comparison of two Aukland hospitals is made. In one the incidence of retrolental fibroplasia in babies whose birth-weight was 4 lbs. had risen to 23.7 percent. In the other no retrolental fibroplasia was found. Oxygen, antibiotics and parenteral fluids were given routinely in the first hospital and not in the second. The giving of oxygen has now been reduced in the first hospital and the incidence of retrolental fibroplasia seems to have been reduced also.

Cortisone (2.5 mgm.), has been injected intravitreally in three early cases of retrolental fibroplasia with improvement in two. (9 figures, 17 references) Robert A. Moses.

François, J., and Verriest, G. **Visual functions in detachment of the retina.** Ann. d'ocul. **188**:97-162, Feb., 1955.

After reviewing the literature, the authors analyse the visual disturbances occurring in 25 new cases of retinal detachment in which detailed pre- and postoperative studies of central vision, scotopic and photopic visual fields, colour vision, light sense, critical fusion frequency, and electroretinograms were made. (47 figures, 74 references) John C. Locke.

Friemann, Werner. **Heredodegeneration of the macula with hyperkinesia.** Klin. Monatsbl. f. Augenh. **126**:460-469, 1955.

Three children (two were siblings) with bilateral macular degeneration are described. Two of the children had chorea and one a tic. (3 figures, 34 references) Frederick C. Blodi.

Gasteiger, H. **Retinal detachment and injury.** Klin. Monatsbl. f. Augenh. **126**: 513-529, 1955.

This legally important problem is reviewed. It is undoubtedly true that a blunt injury to a normal eye may occasionally produce a detachment. This occurs only rarely after a concussion of the entire body. Such eyes have usually a predisposition for a detachment. Heavy work also may occasionally produce a detachment. Even if the injury precipitates a detachment in a predisposed eye (myopia, aphakia) the basis of a compensation is given if it can not be proven that the detachment would have occurred spontaneously at the same time. (23 references) Frederick C. Blodi.

Halbron, Pierre. **Arterial hypertension as a cause of retinal detachment.** Ann. d'ocul. **188**:318-333, April, 1955.

Four cases are presented in which detachment of the retina occurred coincidentally with an elevation of the systemic blood pressure. In a fifth case it followed choroidal detachment in a hypertensive patient. The author feels that these cases

support the concept of a vascular origin in some cases of retinal detachment. (22 references) John C. Locke.

Hansen, A. K., and Stewart, L. C. **Spontaneous retinal detachment in four-year-old child with interesting family history.** A.M.A. Arch. Ophth. **53**:891-892, June, 1955.

The unusual occurrence of spontaneous retinal detachment in a four-year-old child is reported. Scleral resection was unsuccessful. There is blindness due to myopia in the family. (1 figure, 1 reference)

G. S. Tyner.

Hoffmann, W. **The irradiation treatment of vitreous hemorrhages.** Klin. Monatsbl. f. Augenh. **126**:575-580, 1955.

The author uses either X-rays (110 kV, 2 mm Al, 30 cm STD) or radium. Both give approximately the same results. 202 patients were treated. 34 had chorioretinitis and all responded ultimately quite well. 60 patients had a periphlebitis. Half of the eyes affected with this condition regained good vision and only five such eyes remained blind. 34 patients had hypertension and here the recurrence rate was comparatively high. 18 patients had diabetes and here the prognosis was quite poor. The other patients had either a postoperative (cataract, detachment) or traumatic lesion. The treatment does not prevent recurrences and it takes weeks or months. The results are only suggestive and the author urges an evaluation of this method by other ophthalmologists.

Frederick C. Blodi.

Jensen, V. A., and Lundbaeck, K. **Diabetic pigmentopathy of the macula lutea.** Ophthalmologica **129**:88-93, Feb., 1955.

Hypo- or hyperpigmentation of the macular region, similar to that occurring in senile or in heredo-degeneration of the macula, is described as a characteristic manifestation of diabetes of long standing. The visual acuity is not affected by the pigmentary changes. (1 figure, 5 references) Peter C. Kronfeld.

Mark, R. E., and Kaeding, A. **The importance of blood pressure and metabolism for the occurrence of senile fundus changes.** Klin. Monatsbl. f. Augenh. **126**: 534-539, 1955.

These observations were made on 243 diabetic, 243 nondiabetic and 226 hypertonic patients. In all three groups the frequency of fundus changes increased with age. The changes are more frequent in diabetic women than men. Hypertension and diabetes increase arteriosclerotic and degenerative fundus changes approximately equally. (1 figure, 5 tables, 7 references) Frederick C. Blodi.

Marsico, Vincenzo. **The use of ganglioplegics in occlusion of the central retinal artery.** Arch. di ottal. **58**:375-394, Nov.-Dec., 1954.

A hexa-methonium preparation (esonium) was used in six cases of occlusion of the central retinal artery. Daily intravenous injection of 100 mg. resulted in improvement in all cases but one, in which the angiospastic factor was aggravated by severe anatomic changes in the vessel walls. (6 tables, 12 references)

John J. Stern.

Mylius, K. **Extrafoveal fundus changes in the heredo-degeneration of the macula.** Klin. Monatsbl. f. Augenh. **126**:539-546, 1955.

The heredodegeneration of the macula is usually oval and sharply outlined. No other fundus changes accompany it. Three patients were however, observed who developed degenerative (drusen?) changes at the posterior pole in addition to a typical heredodegeneration of the macula. (4 figures) Frederick C. Blodi.

Scullica, Francesco. **The late forms of retinitis pigmentosa. Clinical contribution**

and etiopathogenetic considerations. Ann. di ottal. e clin. ocul. **81**:221-272, June, 1955.

There are sufficient clinical characteristics to suggest that retinitis pigmentosa can start in adult life. The condition can be differentiated from Pillat's senile pigment degeneration. The author has found that 18.3 percent of his cases (81 in all) were of the adult form, as contrasted to the more common form starting in early life. The cases were evaluated on the basis of heredity, onset, first manifestations, visual acuity, fields, light sense and fundus aspect. These data partly confirm and partly modify the characteristics postulated first by Leber. It is concluded that the late form is sufficiently differentiated from the more common, early form of retinitis pigmentosa and Pillat's senile pigment degeneration to be considered an entity by itself. It is suggested that the late form is an expression of meningoencephalitic infection in adults and hence independent of hereditary factors. (17 figures, 70 references) John J. Stern.

12

OPTIC NERVE AND CHIASM

Badtke, G. **Pseudoneuritis and pseudopapilledema in myopia.** Klin. Monatsbl. f. Augenh. **126**:546-561, 1955.

Pseudopapilledema and pseudoneuritis are congenital anomalies of the intraocular part of the optic nerve caused by a faulty embryonal development. They occur usually in hyperopic eyes. However, four myopic patients were observed in whom pseudopapilledema occurred in one or both eyes.

In four histologically examined eyes a pseudopapilledema was incidentally found. Three eyes were of infants and enucleated because of a suspected tumor. The fourth eye was from a 78-year-old man with absolute glaucoma. The pseudopapilledema is either a proliferation of glial tissue in the disc or a prominence of the optic nerve itself. (8 figures, 29 references) Frederick C. Blodi.

13

NEURO-OPHTHALMOLOGY

Angelone, Luigi. **The effect of antitoxic liver extract associated with choline, thiamine, and nicotinamide in neuro-ophthalmology.** Ann. di ottal. e clin. ocul. **81**:183-198, May, 1955.

The author discusses briefly the principal biochemical functions of the liver and calls attention to its importance in making inactive exogenous and endogenous poisons. He calls attention to the association between necrobiotic lesions of the liver and changes in the nervous system, particularly the optic nerve. Cytolysis in the liver may result in circulating neurotoxic substances or the metabolism of the nerve tissue may be disturbed because of the suppression of the hepatic function. In order to normalize and intensify the function of the liver parenchyma it is necessary to associate hepatic extracts with choline, and the nerve cell, so easily affected by poisons, benefits from this normalizing and intensifying of the hepatic function.

Angelone also discusses the pathogenesis of alcohol-nicotine neuritis and the vital phenomena of the retinal cells. He reports four cases of toxic retrobulbar neuritis, three cases of toxic amblyopia and one of orbital neuritis from carbon sulfide, treated with antitoxic liver extract combined with choline, thiamine and nicotinamide and concludes with a critical review of the results obtained. (40 references) John J. Stern.

Bregeat, P., Fischgold, H., and David, M. **Radiography of gliomas of the chiasm.** Bull. et mém. Soc. franç. d'opht. **67**:271-277, 1954.

Radio-anatomic analysis supported by

tomography and radio-graphic enlargement are essential in the diagnosis of abnormalities in the sellar or parasellar region, and in the differential diagnosis of unilateral or bilateral optic gliomas, anterior or posterior pressure on the optic nerve, and pressure by an enlarged third ventricle. Three cases of gliomas of the chiasm, with X-ray studies and interpretation of the various diagnostic procedures, are discussed. (3 references, 7 figures)

Alice R. Deutsch.

Diez, M. A., and Adrogue, E. **Horizontal hemianopsias.** Rev. oto-neuro-oftal. **30**: 39-49, March-April, 1955.

The authors define this type of hemianopsia and emphasize its rarity, especially the upper hemianopsias. They review the different diseases, ocular and general, which may produce this type of hemianopsia and display 24 visual field charts from patients with this defect, and discuss in some detail the way in which some of the infections, tumors or vascular accidents bring about the defects in the field. (24 figures, 10 references)

Walter Mayer.

Dollfus, A., Pichet, C., Meyer-Heine, Dagorne, and Cadran. **A severe case of neuromyelitis optica.** Bull. et mém. Soc. franç. d'opht. **67**:288-298, 1954.

Neuromyelitis optica, Devic's disease, is a rare disease as only 200 cases were found to be recorded. A case is described in detail in a man who happened to be under close observation several weeks befor the onset of visual disturbances and the severe neurological signs and symptoms. Salycilates, urotropine, vitamins and antibiotics were used without results. The use of ACTH, 100 mg. a day, brought about, first a stabilization of the disease, and later a definite improvement when the ACTH injections were repeated. ACTH apparently by its action on the allergic exudative phase and the proliferation of mesenchymatous tissue had a favorable influence on the outcome of this otherwise serious disease.

Alice R. Deutsch.

Dubois-Poulsen, A., and Magis, C. **Scotomas localized in the vertical dividing line of the visual field.** Bull. et mém. Soc. franç. d'opht. **67**:278-287, 1954.

Defects in the medial vertical line of the fields have rarely been described in spite of their specific morphology and localizing significance in inter-hemispheric occipital lesions. The defects are of various shapes, irregular in outline and mostly not symmetrical. The tracing of the scotomas is difficult because small objects disappear completely and the change in the perception of larger targets is vague and tiresome. Details in the interpretations are reviewed, using pertinent case histories.

The first case occurred in a young woman who lost her vision after eclampsia and when partly recovered showed the type of field defect under discussion. In the second patient a bullet became lodged in the interhemispheric occipital region after a gunshot-wound. The third patient, 38 years old, noted a disturbance in vision, after a grand-mal attack. The visual field showed a large medial defect, especially in the lower half of the field, and an enlargement of the blind spot. Arteriography revealed a suspicious lesion between the occipital lobes. A tumor of the falx was found 2 cm. deep and on the junction of the occipito-parietal lobe.

This distinctive field defect seems to be combined with more or less pronounced agnosia for colors, defects in stereoscopic vision, quickening of eye movements, slow recognition of objects in one half of the fields and difficulties in avoiding obstacles, a symptom complex which could be called "syndrome of the midline." (3 figures)

Alice R. Deutsch.

Etienne, Raymond. **A case of erythropsia.** Ann. d'ocul. **188**:182-190, Feb., 1955.

The author reports a case of erythropsia in a 34-year-old woman, which he believes to be neurogenic in origin. The patient alternately had periods of erythropsia and crises of ophthalmic migraine. The treatment of the erythropsia was the same as for the migraine and seemed to give a good result. John C. Locke.

François, J., and Neetens, A. **The Foster Kennedy syndrome and its etiology.** Ann. d'ocul. **188**:219-253, March, 1955.

The authors describe two cases of Foster Kennedy syndrome, one caused by optochiasmic arachnoiditis and sclerosis of the wall of the internal carotid artery, and the other by a tumor in the anterior and middle cranial fossas. They emphasize that the syndrome is not always of neoplastic origin, and that even when there is a tumor this may have various localizations. The association of Foster Kennedy syndrome with inferior binasal quandrantanopia suggests optochiasmic arachnoiditis or sclerosis of the internal carotid artery. (8 figures, 1 table, 103 references) John C. Locke.

Godde-Jolly, Denise. **Intracranial arterial aneurysms of the internal carotid artery and its branches.** Ann. d'ocul. **188**: 27-48, Jan., 1955.

The diagnosis and treatment of various types of intracranial aneurysm of the internal carotid artery and its branches are discussed. The technique and results of arteriography are described. Five cases are reported. (4 figures, 36 references) John C. Locke.

Hoang, Xuan-Man. **Sign of Fuchs or the pseudo von Graefe phenomenon.** Bull. et mém. Soc. franç. d'opht. **67**:298-312, 1954.

Spasmodic retraction of the upper lid is one of the ocular signs of Graves' disease, caused by increased sympathetic excitability and is called von Graefe's phenomenon. A limitation or abolition with or without active contractions in the downward movement of the upper lid in depression or adduction of the eyeball is called pseudo Graefe phenomenon. It is very rare and only follows lesions of the third cranial nerve in the stage of recovery. The injury probably is to the nerve stem; nuclear damage has not been demonstrated in any of the published cases. Among the many neurological patients examined by the author there were only seven who showed the pseudo Graefe phenomenon and had the lesion discussed above. Their case histories are reviewed in detail. (20 references, 1 figure) Alice R. Deutsch.

Kobiela-Krzystkowa, Krystyna. **Pathogenesis of choked disc.** Klinika Oczna **24**: 267-274, 1954.

Theories of pathogenesis of choked disc are presented and discussed. The author favors the theory of compression of the central retinal vein in its passage from the optic nerve through the subdural space. Experiments were conducted on cadavers to check whether there is direct connection between the meningeal space and the subdural space of the optic nerve. Methylene blue was injected below the optice nerve from the side of the cranial cavity and also through an opening in the sheaths of the orbital portion of the nerve. It passed into the subdural space of the optic nerve under pressure of 150 to 200 mm. of water which is about the normal intracranial pressure. The narrow place was in the area of the optic foramen. When the intracranial pressure rises the pressure in the subdural space of the optic nerve also rises and compression of the central retinal vein is very probably the cause of choking of the optic disc. (2 figures, 17 references) Sylvan Brandon.

Offret, G., and Massin, M. **The development of intracranial aneurysms and their**

relationship to the visual apparatus. Bull. et mém. Soc. franç. d'opht. **67**:240-256, 1954.

The importance of arteriography in the diagnosis of intracranial aneurysms and the many difficulties in their treatment are discussed. The group of patients presented are divided into three categories: 1. those with classical ophthalmic migraine, 2. those with monocular, often pulsatile exophthalmos with or without intracranial murmur and combined with a paralysis of the third nerve, and 3. those with monocular optic neuritis. In the three patients in the first group, arteriography showed small aneurysms of the terminal branches of the internal carotids. Three of the patients in the second group had an intracavernous aneurysm and the fourth had the aneurysm at the end-point of the internal carotid artery. Of the patients in the third group, two had the optic neuritis on the side of the aneurysm which involved the ophthalmic artery in one case, and the end of the internal carotid in the other. The third patient had a papilledema and macular star of long standing which justified an exploratory craniotomy and revealed an aneurysm of the contralateral ophthalmic artery. The optic canal on the side of the optic neuritis was unroofed and an improvement of vision achieved.

The treatment of choice in intracranial aneurysms is surgical and consists of either a direct attack on the aneurysm or a ligation of the internal or common carotid arteries. Thrombosed aneurysms which act like a tumor and aneurysms which leak into the subarachnoidal space are absolute indications for surgery. Otherwise extreme caution is advised, the risks of even exploratory craniotomies are stressed, and palliative measures are suggested whenever feasible, even if only temporarily effective. The great responsibility of the ophthalmologist in the diagnosis of intracranial aneurysms is emphasized. Alice R. Deutsch.

Thomas, C., Cordier, I., and Algan, B. **Cortisone treatment in opticochiasmatic arachnoiditis.** Bull. et mém. Soc. franç. d'opht. **67**:257-270, 1954.

The symptoms of opticochiasmatic arachnoiditis are well known and documented by anatomical and pathological findings. The prognosis for vision is serious, because of the ineffectiveness of the present treatment.

Seven patients with opticochiasmatic arachnoiditis were observed. One patient had had a tuberculous meningitis in the past, another had a sinus disease. No etiology could be found in the other five, in spite of a complete examination. Neither surgical nor antibiotic therapy was of any avail. Considerable improvement was accomplished with 100 mg. of cortisone a day, if this hormonal treatment was not started too late and before irreparable damage was done to the optic nerve. The amount of cortisone given depended on the individual findings. Enough cortisone should be given, but strict control is necessary to avoid possible atrophy of the adrenals. In case of recurrent impairment of vision cortisone must be given again. The highest total dose of cortisone given in one patient was 8,200 gm; there were no general signs and symptoms of overdosage. Simultaneous anti-infectious treatment is necessary to avoid a dissemination of the causal infection. (12 references, 7 figures) Alice R. Deutsch.

14

EYEBALL, ORBIT, SINUSES

Appleman, M., Michaels, J., and Jansen, E. **Bilateral orbital metastasis in carcinoma of the breast; detection by radioactive phosphorus.** Bull. et mém. Soc. franç. d'opht. **67**:415-428, 1954.

The case history of a 35-year-old woman with disseminated general metastasis of an untreated scirrhus carcinoma of the right breast is reported. The patient also showed bilateral exophthalmos,

keratitis secondary to lagophthalmos and limited motility of each eyeball. The biopsy of a skin nodule revealed atypical cancer of the breast. A tarsorraphy relieved the severe orbital inflammation. Testosterone, 50 mg., given as a palliative measure, had to be discontinued because of an increase in the ascites. B12 and iron were given to decrease the severe anemia.

This case was presented because of the rareness of orbital metastasis, especially bilateral metastasis, in breast cancer; also because of the difficulties in the differential diagnostics of small orbital lesions and of the possible diagnostic aid of P32, given in doses of 230 to 400 microcuries. Four other observations of unilateral exophthalmos in which radio-active P32 was used, are included. The interpretation of the findings, possible errors and potential dangers in this method are evaluated. (49 references, 3 figures, 2 tables)

Alice R. Deutsch.

Ferrer Arata, A., Gómez Morales, A., and Reforzo Membrives, J. **Clinical orbitotonometry.** Arch. oftal. Buenos Aires **29**:605-631, Dec., 1954.

This excellent study deals with the fundamentals and clinical applications of orbitotonometry, a diagnostic procedure mainly developed in recent years by Copper (Copper, A. C.: An Introduction to Clinical Orbitotonometry, Leydon, S. Kroese, 1948) which permits a quantitative evaluation of both exophthalmos and the retrobulbar resistance and provides useful data on the physical characteristics of the intraorbital tissues. The results obtained in 485 emmetropic, myopic and hyperopic, but otherwise normal persons are carefully analyzed and discussed and a curve presented by means of which the significance of any individual reading can be ascertained at a glance. (5 figures, 6 tables, 1 curve, 17 references)

A. Urrets-Zavalia, Jr.

Heinsius, Ernst. **An implant after enucleation.** Klin. Monatsbl. f. Augenh. **126**: 479-481, 1955.

The hollow implant is made of plastic (Paladon), and has four large tunnels for the rectus muscles. The anterior surface is flat and it is not unlike an Allen implant. One implant out of 32 was extruded and in one instance the conjunctiva opened. (1 figure, 6 references) Frederick C. Blodi.

Macharashvili, P. D. **A case of enophthalmus.** Vestnik Oftalmologii **33**:39, 1954.

A woman, 72 years of age, had enophthalmus and partial atrophy of the optic disc of the left eye. General examination revealed the presence of arteriosclerosis and hypertension. Thirteen years before a hematoma developed on the left side of the face, during an operation in general anesthesia. The author feels that enophthalmus was caused by absorption of the orbital fat after the hemorrhage.

Sylvan Brandon.

Mueller, H., and Littann, K. E. **The tolerance for supramid implants.** Klin. Monatsbl. f. Augenh. **126**:430-433, 1955.

137 balls made of this plastic material were implanted after enucleation. The immediate reaction to the plastic foreign body was severe in 32, and moderate in 46 cases; 11 implants were extruded immediately, 9 later on. In 23 patients supramid was used in a lid plastic or ptosis-operation and in fifteen patients this material served to replace bony defects of the orbital margin. Eight of these implants were extruded or had to be removed. (4 references)

Frederick C. Blodi.

Plessier, D. **A case of endogenous malignant exophthalmos.** Bull. et mém. Soc. franç. d'opht. **67**:429-443, 1954.

The clinical, etiologic and experimental characteristics of malignant exophthalmos are reviewed.

A patient, 52-years-old, with an excep-

tionally severe malignant exophthalmos was studied for several years. Hormone therapy was of no avail. Retrobulbar hyaluronidase 150 U.T.R. relieved the pain and made better closure of the lids possible as long as it was regularly applied. The same was true for the use of ACTH which was given in divided doses of 150 mg. daily. Orbital decompression was followed by severe headaches and ACTH, 100 mg. daily, had to be repeated. Amelioration of pain occurred without change in either the chemosis or protrusion. The best results were achieved with irradiation of the pituitary gland, 3000 r through three portals of entrance (one frontal, two temporal were given). Even then, a considerable protrusion and chemosis persisted.

Early treatment of progressive exophthalmos is advocated. Symptomatic treatment, hormones and irradiation of the pituitary gland should be used with patience and always should precede any kind of orbital decompression. Chemical and surgical reduction of the function of the thyroid should be undertaken with extreme caution. (14 references, 2 figures)

Alice R. Deutsch.

15

EYELIDS, LACRIMAL APPARATUS

Burch Barraquer, Manuel. **The pathology of the lacrimal canaliculus.** Arch. Soc. oftal. hispano-am. **15**:241-261, March, 1955.

In the course of 250 dacryocystostomies, the author found a pathologic condition not heretofore described. In 28 cases there was a rupture and displacement of the common aperture of the canaliculi into the sac, and a dehiscence between the sac and the orbital septum. This condition may account for epiphora with apparently permeable lacrimal passages, and for apparent failure of a properly performed surgical procedure to relieve epiphora. When one irrigates the sac through the inferior canaliculus, the fluid returns immediately through the superior canaliculus and at the same time some of it passes into the nose or distends the sac. If the fluid fills the sac, the surgeon may palpate the sac from the outside and obtain some information about its size. A probe introduced through the inferior canaliculus fails to enter the sac and encounters an elastic resistance at the level of the common canalicular aperture. By gently moving the probe in various directions, one may cause it to find its way through the displaced aperture and enter the sac. To correct this condition the author devised a surgical procedure which is incorporated into the technique for dacryocystostomy. While the sac is open, a probe is inserted through the inferior canaliculus and the surgeon observes the point where it impinges on the outer wall of the sac. With fine scissors, a portion of the outer wall of the sac is removed, and the canalicular opening enlarged; the lacrimal passage is threaded with a silk suture inserted through the inferior canaliculus. The suture is left there for 15 days. Sometimes the common aperture is blocked by a pathologic fold of mucous membrane, which is then extirpated. In 13 cases the sacs were ectatic, and there was rupture and displacement of the common canalicular aperture. After the usual dacryocystostomy nine patients were cured and in four some degree of epiphora persisted; five had complete stenosis with a rupture and displacement of the common canalicular aperture. After the usual dacryocystostomy nine patients were cured and in four some degree of epiphora persisted. Five patients had complete stenosis with a rupture and displacement of the canalicular aperture. They were treated by a dacryostomy, an incision into the external wall of the sac, connecting it with the canaliculi, and an intubation with silk thread for 15 days. Two patients were cured. The three failures were caused by closure of the incision in the sac after the thread was removed. Six

patients were operated upon with the additional technique devised by the author. Five of these were cured. In one patient with a small sac the epiphora persisted in spite of perfect permeability of the passages. (9 figures, 34 references)

Ray K. Daily.

Casanovas, Jose. **Ingrown cilia.** Arch. Soc. oftal. hispano-am. **15**:235-240, March, 1955.

The literature on the growth of eyelashes is reviewed. In-grown cilia are classified as internal, intermarginal and external. The author reports a case of external ingrown eyelash under the skin of the upper lid, in a girl, nine years old. The author agrees with Bloch, that the perverted growth of an eyelash is due to its encountering an abstruction in the process of growth, when it take the course of least resistance. (4 figures, 20 references)

Ray K. Daily.

Cavalheiro Willmersdorf, Jorge. **Dacryocystorhinostomy. A new technique.** Rev. brasil. oftal. 14:121-276, June, 1955.

In this extensive paper the author describes a new technique which he devised because he was dissatisfied with the conventional methods of dacryocystorhinostomy. After the skin incision and exposure of the periosteum, the osteotomy is done with a special bone forceps, the lacrimal sac opened and the posterior portion sutured to the nasal mucosa. A rubber tip from a dropper bottle is then inserted into the bony opening, and fastened to the skin of the nose with a nylon thread; the anterior flaps of the lacrimal sac and the nasal mucosa are sutured over this conformer. The sutures are removed after two days and the conformer is taken out 10 days later. The reason for this conformer is to prevent the premature closure of the bony opening, and according to the author gives excellent results.

The author presents records of 104 cases, and does not mention any foreign body reaction to this conformer or any difficulties associated with its removal such as pain or hemorrhage. (13 figures, 100 references)

Walter Mayer.

Esteban Aranguez, Mario. **A case of multiple angiosarcomatosis involving the lids. (Kaposi's disease).** Arch. Soc. oftal. hispano-am. **15**:265-273, March, 1955.

The author reports a case of angiosarcomatosis in a man, 59 years old, who in addition to the cutaneous lesions had a large tumor in the left upper lid, which produced pseudoptosis. At the urgent request of the patient the author destroyed the tumor with a galvanocautery and achieved an excellent result. The literature on the pathology of Kaposi's disease is reviewed. (4 figures, 9 references)

Ray K. Daily.

Fazakas, Alexander. **Congenital anomalies of the proximal portion of the lacrimal drainage system.** Ophthalmologica **129**:99-106, Feb., 1955.

The author describes a number of congenital anomalies of the topographic relationship between the semilunar plica, the lacrimal lake and the lacrimal puncta. Perfect drainage of the tears requires 1. situation of the lower punctum on the highest point of the junction between the skin fold surrounding the caruncle and a line drawn through the openings of the Meibomian glands, 2. situation of the lower punctum opposite the groove between plica and bulbar conjunctiva, and 3. situation of the upper punctum opposite the groove between plica and caruncle. Surgical methods for the correction of the various congenital anomalies are described. (11 figures, 12 references)

Peter C. Kronfeld.

Lasky, Mortimer A. **Ankyloblepharon filiforme adnatum.** A.M.A. Arch. Ophth. **53**:882-883, June, 1955.

A case of this rare condition is reported —the thirteenth in the world literature.

The bands can be separated with a scissors. (2 figures, 3 references)

G. S. Tyner.

Moro, F. **Herpetic blepharitis following anti-typhoid vaccination (clinical report).** Ann. di ottal. e clin. ocul. **81**:169-174, April, 1955.

A patient with typhoid fever, who was being treated with chloramphenicol was also given typhoid vaccine. The first injection was followed by a mild herpes labialis and the second one by a herpetic blepharitis which healed rapidly. (2 figures, 5 references) John J. Stern.

Solé, Alfons. **Stagoscopy of the tears.** Klin. Monatsbl. f. Augenh. **126**:446-451, 1955.

Stagoscopy is the observation of drops of any fluid. One drop is put on a glass plate and left for drying. The pattern of the dried fluid (stagogram) gives certain indications as to the chemical constituents of this fluid. The colloids remain in the periphery, the salts concentrate in the center. The stagogram of human tears is quite characteristic. It shows a small marginal zone consisting of protein. The central area consists of crystals, some of which form leaf and flower-like structures.

The stagogram of the aqueous of the rabbit resembles that of the cerebrospinal fluid. (7 figures, 8 references)

Frederick C. Blodi.

16

TUMORS

Christensen, L., and Fitzpatrick, T. B. **Keratocanthoma of the ocular adnexa.** A.M.A. Arch. Ophth. **53**:857-859, June, 1955.

The tumor appears as a discrete, solitary lesion and resembles a small papilloma or wart. It grows rapidly, reaching maximal size in four to eight weeks. It has a normal skin color or a pinkish hue due to neovascularization. Since it is benign it should not be treated as a squamous cell carcinoma even though it resembles it histologically. (3 figures, 10 references)

G. S. Tyner.

17

INJURIES

Birich, T. V., Kantor, D. V., Trusevich, T. M., and Sokolova, G. **Character of the present agricultural eye injuries, their prevention and treatment.** Vestnik Oftalmologii **33**:10-13, 1954.

The type of injuries sustained in agriculture have changed and now resemble the industrial type. Metallic intraocular foreign bodies are more frequent than hypopyon ulcers caused by organic foreign matter, which were so numerous before. A major problem is the transportation of the injured to ophthalmologic stations; many of them were brought in eight days after injury. The author observed 156 injuries with 97 penetrating wounds and 68 intraocular foreign bodies.

Sylvan Brandon.

Ferguson, W. J. Wellwood. **Incidence of ocular injuries in coal miners.** Tr. Ophth. Soc. U. Kingdom **74**:95-103, 1954.

The author studied the incidence of miners' nystagmus and ocular injuries in coal miners in relation to the changing conditions of modern mining. Coal seams tend to be less deep and coal cutting is now mechanized. The total number of eye injuries involving a loss of three days or more in 1938 totalled 6,724 and in 1949, 11,058. During the last few years there has been a steady diminution of disability from miners' nystagmus and the lighting at the coal face has been improved. Miners' nystagmus still remains a problem, and efforts must be made in the field of mine lighting. (3 figures, 4 tables)

Beulah Cushman.

Kindel, Marianne. **Intraocular foreign bodies.** Klin. Monatsbl. f. Augenh. **126**: 608-618, 1955.

This study is based on 305 cases seen in the University Clinic in Rostock and on questionnaires sent to 24 German clinics. It is interesting to note that all the clinics use Comberg's localization method. This may be supplemented by Vogt's method of bone-free film, and change of direction of gaze, if indicated. Out of 305 foreign bodies 100 could not be extracted. The diascleral approach was preferred for posterior foreign bodies and about one half of these patients were given good vision. (2 tables)

Frederick C. Blodi.

Klykova, A. L. **Method of extraction of foreign bodies from the deep layers of the cornea.** Vestnik Oftalmologii **33**:28-31, 1954.

The author describes the technique of removing foreign bodies from the deep layers of the cornea. A properly curved spatula was introduced into the anterior chamber through a keratome incision and placed just behind the area of the foreign body. The latter was removed with a spud. This technique was used on 24 patients with good results despite the fact that in eight cases the foreign body was protruding into the anterior chamber. Visual acuity was either maintained or improved. Sylvan Brandon.

Scott, G. I. **Traumatic ulcers of the cornea in miners.** Tr. Ophth. Soc. U. Kingdom **74**:105-116, 1954.

During the period from 1928 to 1938 there was a decrease in the number suffering serious visual disability from over 40 percent to 20 percent, and in the average stay in the hospital from 29.4 to 16.3 days. The improvement is ascribed to early hospitalization and improved sanitation in the pits. Patients were treated with early cauterization. The number suffering severe visual loss was reduced to less than ten percent and enucleation is rare. The recognition that certain sulphonamides could be used locally and could be applied at the pit head resulted in a reduction of 50 percent in the number of cases requiring admission to the hospital. (6 tables, 13 references) Beulah Cushman.

Shereshevskaja, O. J. **Extraction of nonmagnetic intraocular foreign bodies.** Vestnik Oftalmologii **33**:31-35, 1954.

His experience in 12 operations persuaded the author that localization of the foreign body is the most important factor in successful removal. The approach is by the shortest way. Postoperative treatment can clear the vitreous opacities. When removing foreign bodies from the anterior chamber particular care should be taken not to damage the lens capsule. Intraocular foreign bodies, even if they are nonmagnetic, should be removed. Leaving a seemingly inert foreign body may lead to considerable loss of vision or even blindness. Sylvan Brandon.

Velhagen, K. **A disastrous iatrogenic eye injury.** Klin. Monatsbl. f. Augenh. **126**:580-585, 1955.

Eye compresses with a 3 percent sulfocarbolic zinc solution caused complete necrosis of both corneas in a 20-month-old girl. It was prescribed by a general practitioner who had used it for 30 years as an antiseptic solution. In an experiment this solution was instilled into the eye of a rabbit eight times. The cornea became completely opaque after seven days. (5 figures, 18 references)

Frederick C. Blodi.

18

SYSTEMIC DISEASE AND PARASITES

Becker, Bernard. **Retinal complications of diabetes.** Chicago Med. Soc. Cl. Conference pp. 66-69, 1954.

The author notes that diabetics are living longer now, with insulin therapy, and developing more complications. Diabetic retinopathy has increased in incidence from about 8 percent in 1921 to about 50 percent of diabetics now. Dia-

betic retinopathy, diabetic neuropathy, and Kimmelstiel-Wilson disease bear such a constant relationship as to form a new triad. The pathologic and clinical pictures of diabetic retinopathy are described and the adrenocortical theory of pathogenesis is discussed. (8 figures, 8 references) Harry Horwich.

Bellomio, S. **The clinical recognition of ocular ariboflavinosis.** Boll. d'ocul. **34**:157-170, March, 1955.

The author reviews the literature pertaining to ocular manifestations of ariboflavinosis. He apparently has the impression that ocular ariboflavinosis is not uncommon in the United States of America, for considerable emphasis is given to the literature that appeared in the late 30s and early 40s. A detailed case-history of a patient examined and treated by the author is included. (1 figure, 54 references) William C. Caccamise.

Brand, I. **Ocular hypotony in myotonia.** Ophthalmologica **129**:81-88, Feb., 1955.

The eye findings in 19 cases of myotonia are reported. Ocular hypotony appears to be a characteristic of some cases of myotonic dystrophy, that is, those cases in which myotonia is complicated by muscular atrophy. The ocular hypotony, in these cases, is invariably associated with lens changes. (1 table, 28 references) Peter C. Kronfeld.

Breakey, Arnold S. **Ocular findings in cerebral palsy.** A.M.A. Arch. Ophth. **53**: 852-856, June, 1955.

100 unselected patients with cerebral palsy were studied. 56 showed ocular defects which consisted mainly of strabismus. Other defects were developmental ocular abnormalities, gaze palsy and nystagmus. The squints were favorable subjects for occlusion and surgery. (2 tables, 15 references) G. S. Tyner.

Campbell, C. H. **Erythema multiforme exudativum with mucous membrane involvement: with a report of three cases.** M. J. Australia **1**:941-949, June 25, 1955.

After a review of the literature manifestations of the disease are discussed under the following headings—skin, alimentary tract, eyes, respiratory tract, genitalia and other systems. In other sections mortality, differential diagnosis, etiology and treatment are reviewed. Apart from their non-specific effects on the toxic and febrile aspects of the disease it is doubtful whether ACTH and cortisone are of any value and their use should be limited to patients who are critically ill. Three cases of the serious form of the disease with extensive mucous membrane involvement are reported. Cortisone and penicillin were used in the treatment of two. Ronald Lowe.

Caselli, Francesco. **Rare ocular complication of Werlhof's disease.** Arch. di ottal. **58**:411-418, Nov.-Dec., 1954.

In one patient the hemmorhagic thrombocytopenic splenomegalic syndrome of Werlhof was accompanied by a choked disc, retinal hemorrhages and insufficiency of the left external rectus muscle. (17 references) John J. Stern.

Cochet, P., and Benmanour, H. **A case of questionable Kussmaul-Maier disease with ocular manifestations.** Bull. et mém. Soc. franç. d'opht. **67**:461-465, 1954.

The purpose of this publication is to emphasize again the effectiveness of ACTH in colagen diseases. Kussmaul's disease (polyarteriitis nodosa) is characterized by its polymorphism. General symptoms are fever, paleness, fatigue, loss of weight, mild splenomegaly, disturbances of muscle and nerves, skin nodules and various disturbances of the digestive and respiratory tracts and the kidneys. Eye complications are relatively frequent.

The case presented, occurred in a 19-year-old girl with unilateral sclerokeratouveitis. She had been under close observation for over five years. Streptomycin

and Rimifon were of no benefit. ACTH (100 mg. daily) was given in divided doses for three weeks, combined with locally applied atropine and cortone. The results were impressive as far as the disease of the eye and the general health were concerned, but the circulatory disturbances improved but very little. The eye disease did not recur in the course of one year. Alice R. Deutsch.

Comberg, Ute. **Visual disturbances after a criminal abortion.** Klin. Monatsbl. f. Augenh. **126**:625-630, 1955.

250 cc. of a 2-percent soap solution as injected into the uterus. Continuous vaginal hemorrhage followed, but the abortion was not completed until 36 days later. A severe secondary anemia developed. The patient was first blind with retinal hemorrhages and exudates. Vision improved to 1/20 and 6/60. It must be assumed that this visual impairment was due to the severe anemia. (4 figures, 40 references) Frederick C. Blodi.

Davenport, R. C. **Inflammatory vascular diseases affecting the eyes.** Tr. Ophth. Soc. U. Kingdom **74**:5-12, 1954.

The author discusses "perivasculitis" and reports on the association of uveitis and vasculitis. A long interval may separate the retinal from the uveal inflammation. The disturbance may appear first in either tissue or both tissues may be inflammed together or alternately and both arteries and veins may be involved together or separately. If the condition is entirely arterial, hemorrhage does not occur and destruction of tissue will be minimal unless branches are completely obstructed. Venous lesions may be entirely within the nerve stem and give the picture of papillitis with limited evidence of thrombosis of the central vein. The author suggests that this condition may be disseminated sclerosis, associated with multiple, tiny perivascular retinal changes. Four case reports are given. (7 references) Beulah Cushman.

Duguid, J. B. **Periarteritis nodosa.** Tr. Ophth. Soc. U. Kingdom **74**:25-40, 1954.

Periarteritis is of interest to the ophthalmologist because it may affect the eye indirectly by producing hypertension with consequent retinal changes or directly by destroying any one of the arteries of the eye. Any artery in almost any part of the body may be affected or any part of the artery, intima, media or adventitia. The author has felt that the haphazard distribution of lesions must be ascribed to embolism. Emboli vary in size and so may lodge at any point in the arterial system and if infected may lead to almost any kind of inflammatory change. (12 figures, 2 references) Beulah Cushman.

Ferrer Arata, A., and Pianciola, A. S. **Ocular complications in Stevens-Johnson syndrome.** Arch. oftal. Buenos Aires **29**:555-567, Nov., 1954.

Had Hebra's description of erythema exudativum multiforme been recalled more often, the confusion which still arises whenever the names of pluriorificial erosive ectodermosis (Fiessinger, Rendu, Klauder, Yver, Wolff and Thévenarch), Stevens-Johnson disease, Baader's dermostomatitis and Lunedei's dermostomatoophthalmitis are mentioned would have been prevented. As pointed out by Wolff (cf. Wolff, J. E.: Brit. J. Ophth. 33:110, 1949), the condition is characterized by the varied forms of its lesions and may be said to consist of 1. a cutaneous rash of erythemato-papular, vesicular and even bullous elements, of 2. an involvement of the conjunctival, oral, nasal, bronchial, anal and genital mucous membranes, ranging from a mild catarrh to an extremely severe eruption of papular, bullous, membranous and nodular elements, and of 3. systemic disturbances such as fever, headache, dysuria and prostration. While *quoad vitam* prognosis is favorable, the ocular sequelae are frequently serious and may cause a pronounced visual loss. Since no two cases are identical, authors

in various countries have repeatedly described as separate clinical entities what appears to be merely the result of the bewildering polymorphous disposition of the disease.

The case of a 12-year-old boy is presented, in which the disease lasted several weeks and left behind a bilateral marked shrinkage of the conjunctiva and a profusely vascularized corneal opacity. (4 figures, 1 table, 43 references)

A. Urrets-Zavalía, Jr.

Giergielewicz, Halina. **Treatment of scrofulous diseases in children's eyes.** Klinika Oczna **24**:283-291, 1954.

Etiology and pathogenesis of scrofulous eye diseases is discussed. The occurrence of a strong reaction in tuberculin tests is emphasized. Numerous methods of treatment are described. The author presents her experience with 122 children up to 15 years of age. Increased frequency of these conditions was seen in the spring. Frequently scrofulous diseases appeared after a general infectious disease. Children who were three years old were affected more often than the others. Treatment consisted of such general medication as vitamins, cod liver oil and, in wet eczematous conditions, six days of a diet of protein-free food. Locally atropine, yellow oxide of mercury, sulfathiazole, penicillin, streptomycin, cibazol with privine and rimifon were given. It was found that the application of 2 percent rimifon in a saline solution resulted in clear eyes within a few days. The author presents three illustrative cases. (2 figures, 44 references)

Sylvan Brandon.

Joske, R. A. **Essential hyperlipaemia.** M. J. Australia **1**:826-831, June 4, 1955.

Essential lipemia is a genetically determined anomaly of metabolism, with a family history of vascular disease, pancreatico-biliary disease or diabetes mellitus in which some or all of the following clinical findings are manifest: xanthomata of skin or tendons, variable hepatosplenomegaly, pancreatitis, cholelithiasis, atherosclerosis and diabetes mellitus. Biochemical investigation shows persistent hyperlipemia due to an increase of neutral fats and sometimes cholesterol and phospholipids. Treatment is dietetic and symptomatic, but its efficacy is not certainly known. Seven cases are described; four of the patients had xanthelasma of the eyelids.

Ronald Lowe.

Lijó Pavía, J. **Arteriosclerosis, hypertension, and retinography.** Rev. oto-neuro-oftal. **30**:10-18, Jan.-Feb., 1955.

This is the third part of a paper by this author on the importance of the diastolic pressure of the central retinal artery in the evaluation of patients with hypertension and arteriosclerosis. Sudden changes in the diastolic pressure of the central retinal artery often constitute alarm signs before an impending general vascular catastrophe. The author also emphasizes the importance of the determination of the lipoproteins of the plasma, and especially of the cholesterol level as a prognostic sign in the evolution of this type of vascular disease. (5 figures, 1 table, 13 references)

Walter Mayer.

Vanni, V. **Acquired monosymptomatic ocular toxoplasmosis.** Boll. d'ocul. **34**:199-224, April, 1955.

The author reviews the systemic and ocular manifestations of congenital and acquired toxoplasmosis, then discusses acquired toxoplasmosis with apparently only ocular manifestations, especially in the form of uveal and retinal lesions. (1 table, 67 references)

William C. Caccamise.

19

CONGENITAL DEFORMITIES, HEREDITY

Dufour, R., Jequier, M., Cuendet, J. F., and Michels, V. **Cataract and oligophrenia.** Bull. et mém. Soc. franç. d'opht. **67**:318-327, 1954.

This work was supported by the Swiss Academy of Science and was a part of a research project at "Foyer," a home for blind and feeble-minded persons in Lausanne. Thirteen cases of oligophrenia and cataract were found among the 80 inmates. It was not possible to recognize precisely the kind of cataract, as several patients were already operated on and others had a total cataract. In seven patients the cataracts were incomplete. Among them were four zonular cataracts, one zonular with anterior polar opacities and cataracta centralis pulverulenta, one with isolated anterior polar cataract and one with a milky cataract with anterior polar opacity. Associated ocular malformations were microphthalmos in two patients, malignant myopia in one, and juvenile glaucoma in one. Oligophrenia and congenital cataract are both comparatively rare and their frequent association seems to be of importance. No isolated case of either oligophrenia or cataract was found in any member of the family of any of these patients. To establish a clinical entity and call it "cataract-olygophrenic syndrome" distinct from oligophrenic hereditary cerebellar ataxia seems to be justified. The latter is a hereditary affection, possibly caused by a polyphenic gene, sometimes combined with skeletal malformations and transmitted by recessive heredity. (1 figure, 1 table)

Alice R. Deutsch.

Evans, A. T. G. **Essential atrophy of the choroid with paraplegia and a family history of similar conditions.** Tr. Ophth. Soc. U. Kingdom **74**:215-217, 1954.

A man, 40 years of age, began at the age of 17 years to lose the use of his legs and later his arms, and his vision began to deteriorate. A diffuse choroiditis was followed by atrophy. A brother, aged 50 years, had a similar history; his reduced vision was due to a central primary degeneration. Their father died at the age of 43 years with paralysis of both legs and was almost blind, and a paternal aunt and her daughter were similarly afflicted. (1 figure)

Beulah Cushman.

Fischer, Franz. **Pseudophakia adiposa.** Ophthalmologica **129**:160-165, March, 1955.

Pathologic examination of two microphthalmic human eyes revealed the presence, behind the iris, of roughly lens-shaped masses of encapsulated fatty tissue (pseudophakia adiposa). This extremely rare malformation was probably caused by a disturbance of the process of separation of the lens vesicle from the surface ectoderm (2 figures, 6 references).

Peter C. Kronfeld.

Lewis, L. A. **Facial deformity due to deficiency of malar bones and maxillae.** Tr. Ophth. Soc. New Zealand pp. 43-44, 1954.

One case is reported and the literature is reviewed. (1 figure, 3 references)

Robert A. Moses.

Vrabec, F. **An interesting lens anomaly in a cyclopic human fetus.** Ophthalmologica **129**:107-110, Feb., 1955.

In a human fetus of 22 to 24 mm. length the condition of cyclopia was combined with an anomaly of the lens, apparently never before described in a human eye. The closure of the pore of the lens vesicle had been delayed by a process which the author interprets as fixation of a primitive state of the lens by the compact mesodermic tissue of the fetal cleft. (1 figure, 2 references)

Peter C. Kronfeld.

20

HYGIENE, SOCIOLOGY, EDUCATION, AND HISTORY

Calamandrei, Giorgio. **Visual requirements for motor-sport drivers.** Ann. di ottal. e clin. ocul. **81**:199-206, May, 1955.

Precise regulations are urgently needed. The required examinations should include visual acuity, visual fields, color vision, and light sense, as well as motility tests, binocular fields, convergence, accommodation and binocular vision, and examination of the motility of the intrinsic muscles. A neurological examination and a clinical examination of the eye and its adnexa should be obligatory. (22 references) John J. Stern.

Doggart, J. H. **The blind child.** Practitioner **174**:369-374, April, 1955.

There are approximately 100,000 blind people in Great Britain, of whom only 10,000 are under the age of 50. The smaller group, though, actually represents a sizable number of sightless years, and, because of the adaptability of youth, a much greater opportunity for developing a useful, productive life. The subject is discussed in regard to causes, early upbringing, education, and relationship with sighted people. Various facilities for blind children, and many helpful hints on their upbringing and education, even physical exercise, are presented.

Harry Horwich.

Feigenbaum, Argeh. **The use of embryonic tissue for therapeutic purposes, enhancing wound healing, by an eye practitioner of the 12th century—Benevenutus Grapheus Hierosolymitanus.** Acta med. orient. **14**:26-29, Jan., 1955.

Benevenutus Grapheus' description of tissue therapy for ocular wounds is given in detail. It consists of the application twice daily of an ointment made by grinding twelve egg embryos in a well-cleaned metal mortar. This interesting account is further embellished with directions for post-operative care, including the treatment of cataract secondary to the perforating wound. Harry Horwich.

Haber, H. **Safety hazard of tinted automobile windshields at night.** J. Optic. Soc. America **45**:413-419, June, 1955.

This is another condemnation of the green automobile windshields. There can be no doubt that they decrease visibility in night driving. Haber found that the distance at which an object of low contrast would be noticed might be decreased as much as 45 percent by the green windshield. He advises that the 70 percent minimum transmittance requirement for windshields of the American Standard Safety Code be revised. Paul W. Miles.

Haines, H. **An evaluation of the visual status and academic achievement of a selected group of elementary school children over a period of seven years.** Am. J. Optometry **32**:279-288, June, 1955.

A study of 37 children made over several years showed a tendency toward myopia amounting to about 1.50 diopters, and increasing esophoria. These changes were attributed to poor reading habits, posture, short working distance, and emotional problems. Some children may undergo these changes because of schooling before the eyes have matured sufficiently.

Paul W. Miles.

Macdiarmid, D. C. **Two historical ophthalmic cases.** Tr. Ophth. Soc. New Zealand pp. 44-53, 1954.

An amusing account is given of the histories and probable diagnoses of the eye diseases of Sir Joshua Reynolds and of Lord Nelson. (11 references)

Robert A. Moses.

Orlowski, Witold J. **Bibliography of Polish ophthalmic literature. III.** Klinika Oczna **24**:315-318, 1954.

The author presents a bibliography of the polish ophthalmological literature except that which was published in Klinika Oczna. In the year 1945 there were 6 titles, in 1946 there were 21 titles, in 1947, 33 and in 1948, 23 titles.

Sylvan Brandon.

NEWS ITEMS

Edited by Donald J. Lyle, M.D.
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News items should reach the editor by the 12th of the month but, to receive adequate publicity, notices of postgraduate courses, meetings, and so forth should be received at least three months before the date of occurrence.

Deaths

Dr. Neil Isaac Bentley, Detroit, Michigan, died June 22, 1955, aged 73 years.

Dr. Frank Wilson Dean, Council Bluffs, Iowa, died July 3, 1955, aged 92 years.

Dr. James Virgil May, Marinette, Wisconsin, died June 12, 1955, aged 79 years.

Dr. Richard Henry Seely, Trenton, New Jersey, died July 17, 1955, aged 34 years.

Announcements

New Orleans course

A postgraduate program entitled "Ocular pathology" under the chairmanship of Dr. James H. Allen, professor of ophthalmology, will be presented December 5 to 9, 1955, through the Division of Graduate Medicine of Tulane University School of Medicine.

In addition to formal lectures and patient demonstrations, four hours of each day will be devoted to the study of microscopic sections.

Registration must be limited to 12 and registrants will be expected to bring their own microscopes and substage lamps. Inquiries should be addressed to Director, Division of Graduate Medicine, 1430 Tulane Avenue, New Orleans 12, Louisiana.

Pan-American congress

The V Pan-American Congress of Ophthalmology will be held in Santiago, Chile, in January, 1956. The inaugural session will be on Sunday, January 8th, and the scientific session will be held each day from the 9th to the 14th.

The program will consist of a number of symposia in addition to a number of "free" papers. The symposia will include:

1. Collagen diseases, moderated by Dr. John McLean.
2. Glaucoma, moderated by Dr. Peter Kronfeld.
3. Infantile glaucoma, moderated by Dr. A. E. Maumenee.
4. Secondary glaucoma, moderated by Dr. Jorge Valdeavellano.
5. Retinal detachment, moderated by Dr. Humberto Escapini and Dr. Juan Verdaguer.
6. Psychosomatic ophthalmology, moderated by Dr. Daniel Snydacker.
7. Tropical diseases, moderated by Dr. Durval Prado, Dr. Virgilio Victoria, and Dr. Humberto Escapini.
8. The crystalline lens, moderated by Dr. Derrick Vail.
9. Plastic surgery, moderated by Dr. Alberto Gormaz.
10. Visual fields and neuro-ophthalmology, moderated by Dr. Magin Diez, Dr. Manuel Qribe, and Dr. Esteban Adrogue.
11. Intraocular tumors, moderated by Dr. A. B. Reese.

It is planned to have simultaneous translation from Spanish to English and English to Spanish, so that language barriers will be eliminated.

The official travel agent for the Congress is Mr. E. F. Noonan of Journeys International, 6 East Monroe Street, Chicago, Illinois. A line to him will bring you information on travel arrangements. It will be possible also to make reservations through him for rooms at the Hotel Carrera in Santiago where the Congress will be held.

Call for papers

The 1956 meeting of the Section on Ophthalmology will be held in Chicago, June 11-15, 1956, simultaneously with that of the Association for Research in Ophthalmology.

Anyone wishing to present a paper before the section is urged to communicate with Dr. Harold G. Scheie as soon as possible. A title and an abstract of 50 to 150 words must be in his hands by January 1, 1956. Anyone wishing to present a paper before the Association for Research should contact Dr. Lorand V. Johnson as soon as possible.

Members are reminded that their contributions to the Knapp Fund are now due and payable to Dr. Parker Heath, Sullivan, Maine. A $10.00 contribution entitles you to a volume of the 1955 Transactions. Contributions in excess of $10.00 are invited.

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Section on Ophthalmology
313 South 17th Street
Philadelphia 3, Pennsylvania

Dr. Lorand V. Johnson, Secretary
Association for Research in Ophthalmology
10515 Carnegie Avenue
Cleveland 6, Ohio

Congress of Human Genetics

The first International Congress of Human Genetics will be held in Copenhagen, August 1 to 6, 1956. For further information write: The University Institute for Human Genetics, Tagensvej 14, Copenhagen N, Denmark.

Oxford Ophthalmological Congress

The next meeting of the Oxford Ophthalmological Congress will take place in Oxford at the School

of Physiology, South Park Road, on Monday, Tuesday, and Wednesday, July 2, 3, and 4, 1956.

Mr. J. W. Tudor Thomas of Cardiff has been elected master and Mr. O. M. Duthie of Manchester, deputy master.

Dr. Jonas S. Friedenwald of Baltimore has accepted the invitation to deliver the Doyne Memorial Lecture at this meeting and follows in the steps of his father, Dr. Harry Friedenwald, who was the Doyne Lecturer in 1930.

Any American colleagues who might wish to attend the meeting should get in touch with:

Ian C. Fraser
Honorary Secretary
21 Dogpole
Shrewsbury

Gill Hospital congress

The Gill Memorial Eye, Ear, and Throat Hospital, Roanoke, Virginia, will hold its 29th annual spring congress in ophthalmology and otolaryngology and allied specialties, April 2 through April 7, 1956.

Among the guest speakers will be Dr. Rudolf Aebli, New York, New York; Dr. Sam Blank, Philadelphia, Pennsylvania; Dr. John E. Bordley, Baltimore, Maryland; Dr. Virgil S. Casten, Boston, Massachusetts; Dr. Jack S. Guyton, Detroit, Michigan; Dr. Bayard T. Horton, Rochester, Minnesota; Dr. Curwood J. Hunter, Cincinnati, Ohio; Dr. John R. Lindsay, Chicago, Illinois; Dr. John E. Magielski, Ann Arbor, Michigan; Dr. Stephen J. H. Miller, London, England; Dr. Peter N. Pastore, Richmond, Virginia; Dr. Herbert J. Rinkel, Kansas City, Missouri; Dr. C. Dwight Townes, Louisville, Kentucky; Dr. Everett R. Veirs, Temple, Texas; Dr. Henry P. Wagener, Rochester, Minnesota.

Societies

International Medical Assembly

The Interstate Postgraduate Medical Association of North American will conduct an International Medical Assembly at the Municipal Auditorium, Milwaukee, Wisconsin, November 14 to 17, 1955. Of ophthalmic interest on the program will be an address on "Retrolental fibroplasia," by Dr. John C. Locke, demonstrator, Department of Ophthalmology, McGill University, Montreal, Quebec. The address will be a presentation of The Schneider Foundation.

Pennsylvania meeting

On the eye program of the joint meeting of the Pennsylvania Academy of Ophthalmology and Otolaryngology and the Medical Society of the State of Pennsylvania, held recently at the William Penn Hotel, Pittsburgh, were:

"Lethal granulomas of the orbit," Dr. Randolph W. Linhart, Pittsburgh; "Radium D in ophthalmology," Dr. Franklin D. Hoffman, Pittsburgh; "Diagnostic values of radioactive phosphorus," Dr. Thomas D. Evans, Pittsburgh; and "Ocular field changes in functional disease," Dr. William O. Linhart, Pittsburgh.

Sectional meetings

American College of Surgeons

The medical profession at large is invited to attend any of six sectional meetings of the American College of Surgeons, to be held in cities throughout the United States and Canada during 1956. Meeting cities are Jacksonville, Florida, January 16th to 18th; Philadelphia, Pennsylvania, February 13th to 16th; Milwaukee, Wisconsin, February 27th to 29th; Colorado Springs, Colorado, March 5th to 7th; Little Rock, Arkansas, March 12th and 13th; Edmonton, Alberta, April 23rd to 25th.

These meetings, like the five-day annual clinical congress, are designed for the purpose of disseminating information about new methods and therapies. In these programs the college draws on surgeons of outstanding ability, acting as teachers, to focus attention on problems encountered in day-to-day practice. Panels, symposia, papers, and medical motion pictures of greatest value to doctors practicing in the area are presented. What the surgeons want and whom they want to hear determine the programs, for these meetings are planned by local committees and aided by the college. Attendance at these sectional meetings grows each year, an indication of the modern surgeon's desire to keep informed. Further information may be obtained from Dr. H. Prather Saunders, Associate Director, American College of Surgeons, 40 East Erie Street, Chicago 11, Illinois.

Central Illinois Meeting

The following ophthalmic papers were presented at the 25th annual meeting of the Central Illinois Society of Ophthalmology and Otolaryngology, held recently at Bloomington, Illinois:

"The relationship of pseudoptosis to muscle tropias and the palpebral aperture," Dr. Rudolf Aebli, New York; "Some practical points in corneal surgery," Dr. Edmund B. Spaeth, Philadelphia (discussion led by Dr. Wilfred E. Fry, Philadelphia); "Cataract extractions following operations for glaucoma," Dr. Harold Scheie, Philadelphia; "Recent trends in ocular surgery," Dr. Ramon Castroviejo, New York; "Pterygium," Dr. Forrest Pinkerton, Honolulu; "The operative treatment of glaucoma" and "Treatment of chemical burns of the eye," Dr. Arnold Pillat, Vienna; "The management of penetrating wounds of the eye," Dr. P. Robb McDonald, Philadelphia; "The therapy of ocular hypotonia" and "Reinforcement of the sclera during intraocular operations," Dr. Harold Henkes, Rotterdam, Holland; "The present status of tonography," Dr. Peter Kronfeld, Chicago; "Itinerant ophthalmology in Alaska," Dr. E. Harrison Leer, Juneau; "Some observations on the retraction syndrome," Dr. Trygve Gundersen, Boston; "Arteriosclerotic optic atrophy," Dr. Donald J. Lyle, Cincinnati.

District of Columbia

Meetings of the Section on Ophthalmology, The Medical Society of the District of Columbia, Washington, D.C., are scheduled for October 25 and December 13, 1955, and February 14 and April 10, 1956. New officers for the section are: Dr. William D. Foote, president; Dr. Robert E. Duprey, vice-president; Dr. M. Noel Stow, secretary-treasurer.

Philadelphia meeting

On the ophthalmology program at the American College of Surgeons meeting in Philadelphia, February 13 to 16, 1956, are:

Wednesday, February 15th, 8:00 a.m. to 12:00 noon: Clinics in local hospitals; 2:00 to 5:00 p.m., South Garden, Bellevue-Stratford, Dr. Harold G. Scheie, Philadelphia, presiding:

Symposium on recent advances in ophthalmic surgery: "Cataract surgery," Dr. John M. McLean, New York; "Glaucoma surgery," Dr. Paul A. Chandler, Boston; "Reconstruction of the lids," Dr. Wendell L. Hughes, Hempstead, New York; "Present state of surgery of retinal detachment," Dr. Charles L. Schepens, Boston; "Lamellar transplantation," Dr. R. Townley Paton, New York.

Thursday, February 16th, 8:00 a.m. to 12:00 noon: Clinics in local hospitals; 2:00 to 5:00 p.m., South Garden, Bellevue-Stratford, Dr. Albert D. Ruedemann, Detroit, presiding:

Symposium on the management of exophthalmos: "Exophthalmos due to pathology in the orbit or adjacent structures," Dr. Lorenz E. Zimmerman, Washington; "Endocrine aspects of exophthalmos," Dr. Edward Rose, Philadelphia; "Treatment of exophthalmos from the viewpoint of the internist," Dr. William Jefferies, Cleveland; "Treatment of exophthalmos from the viewpoint of an ophthalmologist," Dr. John W. Henderson, Rochester, Minnesota.

At 6:30 p.m. on Thursday, February 16th, there will be a dinner at the Warwick Hotel sponsored by the Section on Ophthalmology of the College of Physicians of Philadelphia. Tickets will be $10.00, and they may be obtained by contacting Dr. Harold G. Scheie, 313 South 17th Street, Philadelphia 3, Pennsylvania.

At the evening meeting, the speaker will be Dr. Paul A. Chandler, Boston.

Nassau society

The Nassau (County, New York) Ophthalmological Society met at Roslyn on September 26th. The paper of the evening was presented by Dr. Thomas M. D'Angelo and Mr. William Richardson. Its subject was "The rising cost of mal-practice." The next meeting of the society will be on November 28th. Officers are: Dr. Frank M. Green, president; Dr. Conrad Berens, vice president; Dr. Eugene T. Buckley, secretary-treasurer; Dr. Arthur E. Merz, assistant secretary-treasurer; Dr. Wendell L. Hughes and Dr. Anthony Scimeca, council members.

Personals

Charles W. Shilling, M.D. (Capt. MC, U.S.N. Ret.), who is well known to many ophthalmologists for his splendid work in ophthalmic research, has retired from the Medical Corps of the United States Navy after 28 years of service. Captain Shilling is now special assistant to the director, Division of Biology and Medicine, Atomic Energy Commission, Washington, D.C.

The appointment of Dr. David G. Cogan, Director of the Howe Laboratory of Ophthalmology of the Harvard Medical School and the Massachusetts Eye and Ear Infirmary in Boston, to serve on the National Advisory Neurological Diseases and Blindness Council, has been announced by Surgeon General Leonard A. Scheele of the Public Health Service, U. S. Department of Health, Education, and Welfare.

Dr. Cogan, a noted investigator into the causes of blindness, has served as a consultant to the National Research Council, the Public Health Service, the World Health Organization and other groups interested in ophthalmic disorders. With his new appointment, he becomes one of the 12 Council members who advise the Surgeon General on an important part of the research program of the National Institute of Neurological Diseases and Blindness, Bethesda, Maryland.

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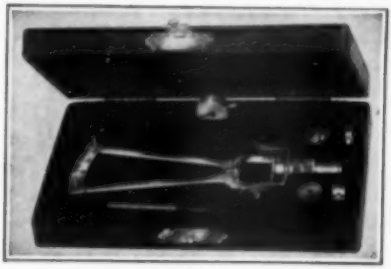

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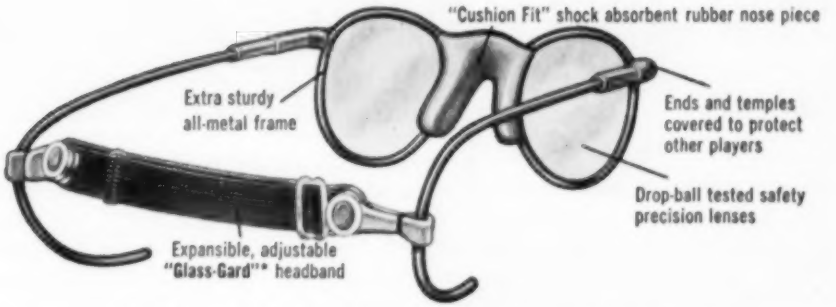
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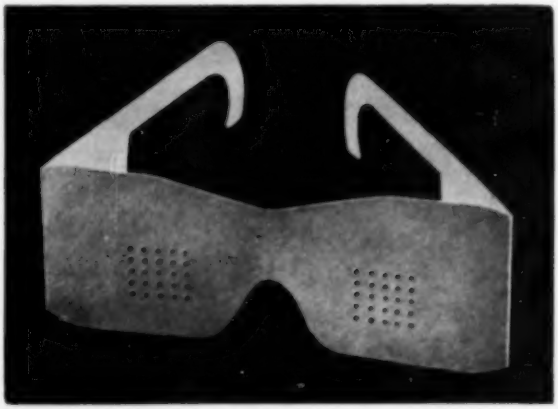

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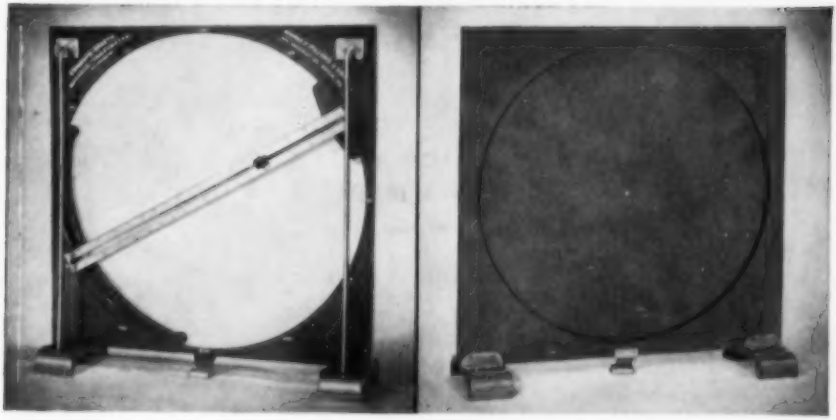

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